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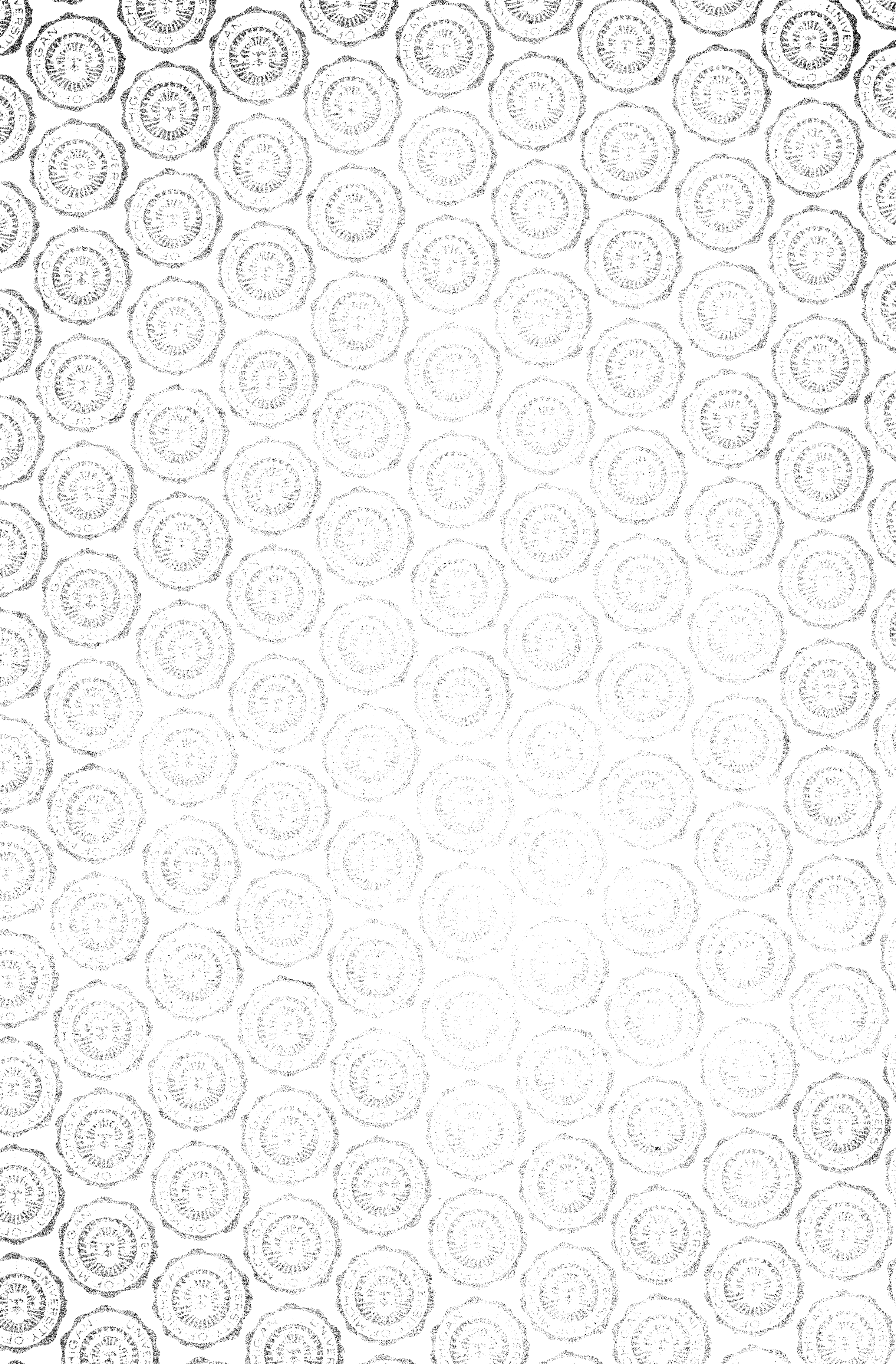

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THE PHILIPPINE JOURNAL OF SCIENCE

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PHILIPPINE EUCALYPTUS OIL

By AUGUSTUS P. WEST and H. TAGUIBAO

Of the Bureau of Science, Manila

TWO PLATES

Eucalyptus trees are native of Australia where they form about three-quarters of the vegetation of that continent. The eucalypts have been introduced into many other warm countries where they are now cultivated. Over three hundred species of eucalypts are known. These trees are evergreens and some of them occasionally reach a height of over 400 feet (122 meters). In Australia they are called gum trees, but the exudation from these trees is not really a gum but rather resembles an astringent tannin known locally as a kino. Eucalyptus trees are valuable for the rapidity of their growth, the usefulness of their timber, and the essential oils contained in their leaves.

Eucalyptus trees have been growing for some years in the highlands of the Philippines. Recently we distilled the leaves of various species of these eucalypts. When calculated on the weight of moist green leaves the yield of oil obtained varied from about 0.01 to 1.96 per cent. The highest yields of oil were obtained from *Eucalyptus globulus*, *E. tereticornis*, *E. polyanthemos*, and *E. citriodora*. Some of these trees gave over 4 per cent of eucalyptus oil calculated on a moisture-free basis. The quality and cineol content of oil obtained from *E. globulus* compared favorably with that of oil distilled from the same species in Australia.

In Australia Baker and Smith [1] have carried out many investigations on the composition of oils obtained from numerous species of eucalyptus trees. Their results have shown that the essential oils obtained from different species may vary considerably in composition and also in yield. Oil obtained from a definite species grown in different localities usually has a comparatively constant composition. According to these authors, "this constancy of constituents must be taken into consideration in the diagnosis of doubtful species. Supposed allied forms that do not individually show chemical constituents in close agreement cannot consequently be the same species." Penfold [2] states that some eucalypts, such as certain varieties of *E. dives*, are so very much alike that they cannot be distinguished botanically according to morphological characteristics. They may be differentiated, however, by their distinctive individual leaf oils which differ in composition and physical properties.

Various eucalyptus oils are now used in the perfumery industry for scenting soaps and for similar purposes. Some oils which contain phellandrene and piperitone are employed in mineral separation by the flotation process. Eucalyptus oils are also used in certain pharmaceutical preparations and also for the manufacture of cheap disinfectants. The germicidal values of various pure constituents in some of these oils have been found to have high Rideal-Walker coëfficients varying from about 5 to 22.

The pharmacopœias of the United States and other countries specify the oil of *Eucalyptus globulus* as official and require a high cineol (eucalyptol) content because the medicinal value of eucalyptus is generally supposed to depend upon the amount of cineol contained in the oil. However, it is doubtful if the value of the oil really depends only on the cineol content for, according to Penfold,[3] the medicinal properties of eucalyptus were founded originally upon those oils which did not contain cineol. Only small quantities of oil from *E. globulus* are now distilled in Australia as there are other eucalypts, such as *E. australiana*, which give much higher yields.

There are a number of eucalyptus trees growing at Baguio, a summer resort situated at an elevation of about 1,500 meters

[1] The Eucalypts and their Essential Oils, Sydney Technological Museum Education Series 24 (1920) 7 and 11.

[2] Journ. Chem. Ed. 9 (1929) 1196.

[3] Journ. Chem. Ed. 6 (1929) 1196.

in the mountain province of the Philippines. The forester, S. Laraya, in charge of the forestry nursery at Baguio estimates that there are now about 5,000 eucalyptus trees in Baguio and the vicinity. These trees are located approximately as follows:

Location.	Estimated number of trees.
Forbes Park	600
Baguio City	3,000
Busol Forest Reserve	400
Camp 8 Plantation, Benguet Road	200
Lucban Hill Plantation	500
Santo Tomas Trail Plantation	300

They range in height from about 2 meters for the younger trees to about 23 meters for the older ones. As usual with eucalyptus the leaves of these trees were found to be in excellent condition and not infected with any kind of fungus growth.

EXPERIMENTAL PROCEDURE

During the spring of 1929 we decided to investigate the oil content of Philippine eucalyptus trees. Through the courtesy of the Commanding Officer of Camp John Hay we obtained permission to use the plumber's shop at this military post as a field laboratory. The army officers very kindly provided us with electric lights and laboratory tables. All necessary chemical supplies and equipment were transported from the Bureau of Science in Manila to this field laboratory in Baguio.

The trees selected for our investigation were numbered, and a metal label containing the number was attached firmly to each tree for future identification. The data concerning these trees are recorded in Table 1, which gives the number of each tree, name, approximate location, and conditions of growth, such as height and position (shady or sunny) on hillside or elsewhere. As shown by the data (Table 1), we selected for our investigation eucalyptus trees of various sizes and growing under different conditions.

In Baguio, during the late springtime, afternoon and evening showers occur frequently. The moisture content of moist, damp eucalyptus leaves gathered early in the morning is greater than that of leaves gathered later in the day when the sun is overhead and the temperature is much higher than in the early morning. If the oil content of the leaves is calculated on the weight of the green leaves then, due to the moisture present, the percentage of oil in leaves from the same tree will vary according to when the leaves are gathered, whether in the early morn-

TABLE 1.—*Location and description of Philippine trees selected for distilling eucalyptus oil.*

Tree No.	Location.	Height.	Position.	Light.	Species.
		Meters.			
	Forest nursery:				
31-A	South of office	14	Level land	Sunny	*E. robusta.*
31-C	Opposite office	16	do	do	*E. globulus.*
31	Road to Bureau of Agriculture Experiment Station	2.5	do	do	Do.
31-D	Do	9	do	Half shady	*E. tereticornis.*
31-E	Do	17	do	Sunny	Do.
31-F	Do	10	do	do	Do.
32-A	Do	7	do	do	*E. polyanthemos.*
32	East of office	3.5	do	do	Do.
33	Do	18	do	do	*E. viminalis.*
34	Do	10	do	Half shady	*E. pulverulenta.*
35	Back of office	20	do	do	*E. tereticornis.*
36	Do	22	do	do	*E. viminalis.*
37	Do	22	do	do	Do.
38	West of office	20	do	Sunny	*E. robusta.*
39	Junction of Leonard Wood Road and Gibraltar Road	13	do	Half shady	*E. globulus.*
	Session Road:				
40	Near Military Circle	11	do	Sunny	*E. corymbosa.*
40-A	Do	10	do	do	Do.
40-B	Do	11	do	do	Do.
41	Do	13	do	Half shady	*E. saligna.*
42	Near City Ice Plant	12	do	Sunny	*E. corymbosa.*
43	Do	13	do	do	*E. melliodora.*
45	Do	12	do	do	*E. crebra.*
44	Below Quezon Cottage	20	do	Half shady	*E. saligna.*
54	Crossing of Session Street at Japanese Bazar Garage	11	Hillside	Sunny	*E. paniculata.*
46	City Ice Plant Road	10	Level land	Half shady	*E. hemiphloia.*
47	Do	20	do	Sunny	*E. citriodora.*
48	Do	22	do	do	*E. rostrata.*
49	Near Cottage No. 6	11	do	Half shady	*E. paniculata.*
50	Do	23	do	Sunny	*E. saligna.*
64	East of City Ice Plant Building	12	do	Shady	*E. pilularis.*
	Luneta Hill:				
51	Opposite University Building	10	Hilltop	Sunny	*E. globulus.*
52	Luneta hillside	3	do	Half shady	*E. citriodora.*
52-A	Opposite Vallejo Hotel	10	Hillside	do	Do.
	Pack Road:				
53	Side of Baguio Chamber of Commerce Building	15	Hilltop	Half shady	*E. pulverulenta.*
53-A	Do	14	do	do	Do.
55	Side of Japanese School Building	20	Level land	Sunny	*E. stuartiana.*
55-A	Do	16	do	do	Do.
56	Do	11	do	do	*E. pulverulenta.*

TABLE 1.—*Location and description of Philippine trees selected for distilling eucalyptus oil*—Continued.

Tree No.	Location.	Height.	Position.	Light.	Species.
		Meters.			
57	City Hill Park	7	Level land	Half shady	*E. melliodora.*
	Busol Forest Reserved Plantation:				
58	Near Laborer's Camp Cottage	10	Hillside	Sunny	*E. robusta.*
59	Above the Creek	10	do	Half shady	*E. saligna.*
60	Road to Laborer's Camp	2	do	Sunny	*E. globulus.*
	Forbes Park No. 2:				
61	Near bridge trail	7	Level land	Shady	*E. microcorys.*
62	Below Teacher's Camp	13	do	Half shady	*E. siderophloia.*
63	Do	13	do	do	*E. microcorys.*

ing or at noon. In order to have a definite standard for comparison it would seem that the oil content of the leaves should be calculated on a moisture-free basis. It should make practically no difference then at what time of the day the leaves are gathered as leaves from the same tree should always give approximately the same oil content.

When the usual method for determining moisture was employed, the eucalyptus leaves naturally lost not only moisture but also the volatile eucalyptus oil. When the crushed leaves were heated in an oven (100° C.) to a constant weight the dried residue consisted of nonvolatile solids and usually contained also small quantities of nonvolatile oils. The dried residue had only a very slight odor and, when distilled with water, only a very small quantity of oil was found to be in the distillate although the distillate had a rather strong odor quite unlike cineol. When the dried residue from a quantity (25 grams) of crushed leaves was distilled, the ether extract of the distillate gave only 0.0016 gram of oil.

In calculating the results of our experiments we have based our calculations both on the weight of moist green material and also on a moisture-free basis. Our experimental procedure was as follows: A quantity of eucalyptus leaves from a particular tree was ground in a meat grinder. The pulp was mixed thoroughly and a sample (100 grams) treated with water and distilled about two hours. According to our experiments this is a sufficient length of time to remove practically all the volatile oil from 100 grams of leaves. The eucalyptus oil was obtained from the aqueous distillate by extracting with ether. The ether

extract was then dehydrated with sodium sulphate, filtered, and the ether removed by distilling on a water bath.

For the moisture determination a sample of ground leaves (2 grams) was heated in an oven at a temperature of 100° C. to constant weight. This required usually about eighteen hours. The loss in weight represented the moisture and volatile oil. The residue consisted of nonvolatile solids together with a small quantity of nonvolatile oil. The results were calculated on the basis of 100 grams of leaves. The following notes give a summary of one of our experiments:

100 grams of moist green eucalyptus leaves distilled gave 1.62 grams of eucalyptus oil.

100 grams of leaves dried to constant weight gave a loss in weight of 62.57 grams.

100.00 grams of eucalyptus leaves.
62.57 moisture and volatile oil in 100 grams of leaves.
37.43 nonvolatile solids and nonvolatile oil in 100 grams of leaves.

62.57
1.62 volatile oil.
60.95 moisture.

100.00
60.95
39.05 volatile oil, nonvolatile oil, and nonvolatile solids in 100 grams of moist green leaves.

$\frac{1.62 \times 100}{39.05} = 4.15$ per cent of volatile eucalyptus oil calculated on a moisture-free basis.

Analysis of eucalyptus leaves calculated on the weight of moist, green leaves would then be as follows:

	Per cent.
Eucalyptus oil	1.62
Nonvolatile oil and solids	37.43
Moisture	60.95
Total	100.00

The oil in Philippine eucalyptus trees, as in eucalypts grown elsewhere, seems to be located almost entirely in the leaves, for when the wood and branches of Philippine trees were distilled only traces or very small amounts of oil were obtained. For the few trees investigated the results given in Table 2 indicate

that large leaves of individual trees contained more oil than small leaves. Some trees have both elongated and rounded leaves. The rounded leaves appeared to contain a slightly larger proportion of oil than the elongated leaves.

TABLE 2.—*Eucalyptus oil in different kinds of Philippine eucalyptus leaves.*

Tree No.	Height of tree.	Kind of leaf.	Analysis.			
			Moisture.	Nonvolatile oil and solids.	Eucalyptus oil in green leaves.	Eucalyptus oil calculated on moisture-free basis.
	Meters.		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
31	2.5	Small	72.18	27.01	0.81	2.91
31	2.5	Large	65.75	32.53	1.72	5.02
39	13	Small	64.71	34.67	0.62	1.76
39	13	Large	60.90	38.10	1.00	2.57
47	20	Small	63.73	34.98	1.29	3.56
47	20	Large	57.72	40.32	1.96	4.64
31-B	20	Rounded	53.12	45.02	1.86	3.97
31-B	20	Elongated	52.61	45.79	1.60	3.38
31-C	16	Rounded	56.00	43.01	0.99	2.25
31-C	16	Elongated	56.26	42.95	0.79	1.81

As there are a number of species of eucalyptus trees in the Philippines our present investigation consisted principally in distilling the leaves of these various eucalypts in order to determine which species gave the highest yields. The results are recorded in Table 3.

As shown by the results the leaves of Philippine eucalyptus trees gave, in general, only a small percentage of essential oil. A few of the trees, however, gave yields of more than 1.5 per cent calculated on a moisture basis. The data (Table 3) show also the difference between calculating the yield of eucalyptus oil on the weight of moist, green leaves and on a moisture-free basis. When calculated on the weight of moist, green material, the leaves of trees 53 and 32–A gave approximately the same yield of oil. When calculated on a moisture-free basis the leaves of tree 53 gave a much higher yield of oil (3.06 per cent) than the leaves of tree 32–A (2.48 per cent). Since other analyses (Table 3) gave the same kind of results, it would seem that the correct standard for comparing the oil content of different trees would be to make the calculation on a moisture-free basis.

TABLE 3.—*Eucalyptus oil in mature leaves of Philippine eucalyptus trees.*

Tree No.	Height of tree.	Analysis.			
		Moisture.	Nonvolatile oil and solids.	Eucalyptus oil in green leaves.	Eucalyptus oil calculated on moisture-free basis.
	Meters.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
31-A	14	57.75	42.20	0.05	0.12
31-D	9	55.96	42.54	1.50	3.41
31-E	17	58.37	40.70	0.93	2.23
31-F	10	60.95	37.43	1.62	4.15
32	8.5	53.06	45.33	1.61	3.43
32-A	7	56.40	42.52	1.08	2.48
33	18	60.93	38.61	0.46	1.18
34	10	55.98	43.48	0.54	1.23
35	20	61.77	37.57	0.66	1.73
36	22	61.67	37.58	0.75	1.96
37	22	58.35	41.26	0.39	0.94
38	20	54.36	45.60	0.04	0.09
40	11	51.73	48.21	0.06	0.12
40-A	10	51.99	47.93	0.08	0.17
40-B	11	54.25	45.65	0.10	0.22
41	13	60.32	39.54	0.14	0.35
42	12	56.01	43.98	0.01	0.02
43	13	60.29	39.53	0.18	0.45
44	20	63.80	36.15	0.05	0.14
45	12	66.04	33.65	0.31	0.86
46	10	67.17	32.10	0.73	2.22
48	22	58.07	41.86	0.07	1.70
49	11	64.19	35.52	0.29	0.81
50	23	68.54	31.42	0.04	0.13
51	10	62.24	36.15	1.61	4.26
52	3	59.27	39.08	1.65	4.06
52-A	10	59.04	39.16	1.80	4.39
53	15	65.74	33.21	1.05	3.06
53-A	14	64.62	34.62	0.76	2.15
54	11	64.55	35.30	0.15	0.42
55	20	59.88	39.67	0.45	1.12
55-A	16	59.92	39.82	0.26	0.65
56	11	57.37	41.56	1.07	2.51
57	7	55.47	44.16	0.37	0.83
58	10	44.40	55.44	0.16	0.29
59	10	53.21	46.64	0.15	0.32
60	2	48.28	50.96	0.76	1.47
61	7	57.52	42.31	0.17	0.40
62	13	54.85	44.32	0.83	1.84
63	13	58.44	41.21	0.35	0.84
64	12	59.82	39.83	0.35	0.87

Data on Philippine trees which gave the highest yields of eucalyptus oil are given in Table 4. By careful cultivation of these particular species of eucalypts it might be possible to produce trees which would give much higher yields of oil.

Possibly, if these species were cultivated in other parts of the Philippines where the soil conditions are different the yield of oil might be larger than in Baguio.

TABLE 4.—*Philippine trees which gave the highest yields of eucalyptus oil.*

Tree No.	Location.	Height.	Species.	Yield of eucalyptus oil. Calculated on weight of moist green leaves.	Calculated on a moisture-free basis.
		Meters.		*Per cent.*	*Per cent.*
	Forest nursery:				
31	Road to Bureau of Agriculture Experiment Station	2.5	*E. globulus*	1.72	5.02
31-B	Opposite office	20	do	1.86	3.97
	Luneta Hill:				
51	Opposite to University Building	10	do	1.61	4.26
	Forest Nursery:				
31-D	Road to Bureau of Agriculture Experiment Station	9	*E. tereticornis*	1.50	3.41
31-F	Do	10	do	1.62	4.15
32	East of office	3.5	*E. polyanthemos*	1.61	3.43
47	City Ice Plant Road	20	*E. citriodora*	1.96	4.64
	Luneta Hill:				
52	Luneta hillside	3	do	1.65	4.06
52-A	Opposite Vallejo Hotel	10	do	1.80	4.39

Baker and Smith [4] report that in Australia the yield of essential oil from *E. australiana* varies from 2.5 to 3.3 per cent depending on the season, and one sample of leaves which was somewhat dry gave a yield of 4.4 per cent. These yields are usually high and much greater than those obtained from any of the Philippine eucalypts which we have investigated. However, when calculated even on a moisture basis, the yields in Australia from *E. globulus* (0.92 per cent), *E. tereticornis* (0.50 per cent), *E. polyanthemos* (0.83 per cent), and *E. citriodora* (0.85 per cent) were very much less than the corresponding yields (1.50 to 1.96 per cent) which we obtained in the Philippines for these particular species. When calculated on a moisture-free basis our yields for these species were very high. Some trees gave an oil content of more than 4 per cent.

As *Eucalyptus globulus* is, perhaps, one of the most widely known species of eucalypts we distilled a quantity of this oil in order to determine the constants and quality of it. This oil

[4] The Eucalypts and their Essential Oils, Sydney Technological Museum Education Series 24 (1920) 171, 165, 208, 99, and 115.

which had a light amber color and a rather intense cineol odor, was found to have the following constants:

Specific gravity $(d \frac{30^\circ \text{ C.}}{30^\circ \text{ C.}})$, 0.9189

Refractive index $(N \frac{29^\circ \text{ C.}}{\text{D}})$, 1.4636

Specific rotation $(A \frac{30^\circ \text{ C.}}{\text{D}})$, +5.06

The cineol content of the oil from *E. globulus* was determined according to the methods given by Baker and Smith.[5] The pharmacopœia preliminary test indicated a cineol content of about 80 per cent. The rapid phosphoric acid-petroleum ether method gave a cineol content of 60 per cent.

SUMMARY

We have investigated several species of eucalyptus trees growing at Baguio, in the highlands of Luzon, Philippine Islands. These trees were of various sizes and growing under different conditions. The results of our experiments have shown that in these Philippine trees the eucalyptus oil is located almost entirely in the leaves for when the wood and branches were distilled only traces or very small amounts of oil were obtained.

The particular species which gave the highest yields of eucalyptus oil were *E. globulus, E. tereticornis, E. polyanthemos,* and *E. citriodora.* These eucalypts gave higher yields of oil in the Philippines than in Australia. The leaves of some of these trees gave yields of over 4 per cent calculated on a moisture-free basis. The yield of oil was also calculated on the weight of moist green leaves but, as shown by our figures, the results are apt to be misleading due to the variable amount of moisture contained in the leaves.

The constants and cineol content of the oil obtained in the Philippines from *E. globulus* were found to compare favorably with similar data on the oil distilled from the same species in Australia.

[5] Op. cit. 364.

ILLUSTRATIONS

PLATE 1. PHILIPPINE EUCALYPTUS TREES IN BAGUIO.

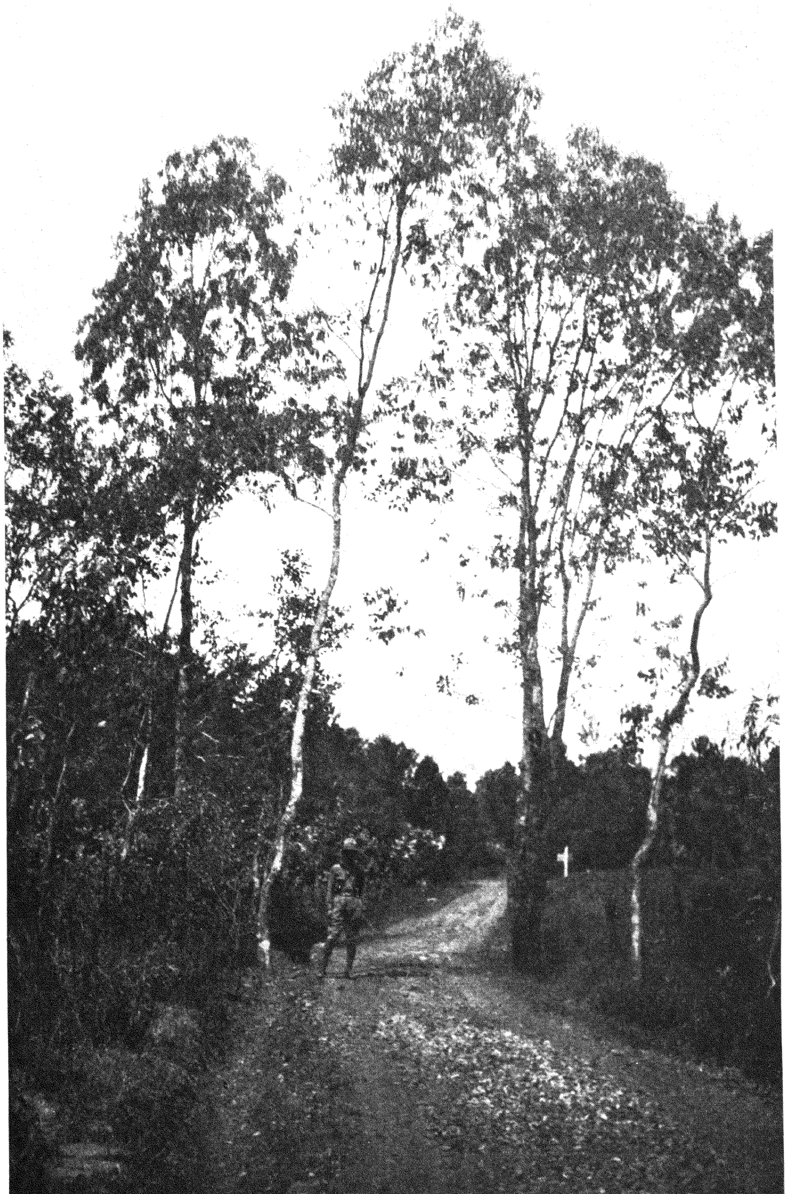

PLATE 2. PHILIPPINE EUCALYPTUS TREES IN BAGUIO.

NOTES ON PHILIPPINE TERMITES, IV

By S. F. Light

Professor of Zoölogy, University of California, Berkeley

EIGHT PLATES AND ONE TEXT FIGURE

Since the publication of my second note on Philippine termites (1921) much time has been devoted to the study of my extensive collection from the Archipelago, consisting of some two thousand vials. This study has been directed not merely towards classification of this material but also towards a search for more satisfactory bases for specific diagnosis. One result has been the development of a system of characters of proportion (Light, 1927) rather than the mere measurements so much relied upon in the past, and the second a ripening of the impression, early gained, of the very extensive range of variation to be expected within a termite species. This variation is to be found not only between members of different termite colonies but also among members of the same colony. It affects not only size but also position of parts, such as the position of the ocelli in the reproductives, etc. A study of the Chinese and Philippine species of the genus *Termes* (*Odontotermes*) soon to be published will present this situation.

As a result of these studies, I am convinced that many of the described termite species are not valid and that only by the study of extensive collections can the taxonomy of the species be revised. The refinements of investigation found necessary to a satisfactory determination and description of species has and will delay the appearance of my reports on the various genera of Philippine termites.

It seems worth while, therefore, for the convenience of entomologists, zoölogists, and others interested, to take stock of our present knowledge of Philippine termites; to describe species that represent genera new to the Islands, and others long described in manuscript, using the older method in order to make them available without long delay; to make certain corrections in previous work; and to present a working key to the genera of the Archipelago and a list of the known species.

Four of the species described in this note, three of them new to science and all new to the Philippines, belong to genera or subgenera hitherto unrecorded from the Islands, as follows:

Glyptotermes chapmani sp. nov.
Grallatotermes admirabilus sp. nov.
Lacessititermes palawanensis sp. nov.
Nasutitermes (*Havilanditermes*) *atripennis* (Haviland).

The first three represent genera new to the Philippines. *Havilanditermes* is a new subgenus erected to receive *Termes atripennis* Haviland, here reported from the Philippines for the first time. This is the first termite species definitely known to be common to Borneo and the Philippine Archipelago.

This note also includes descriptions of four other new species, all in the genera *Kalotermes* s. s. and *Neotermes*, as follows:

Kalotermes taylori sp. nov.
Neotermes grandis sp. nov.
Neotermes parviscutatus sp. nov.
Neotermes microphthalmus sp. nov.

The Philippine termite fauna as known, with the above additions, includes eighteen genera and subgenera. Hagen (1858) reported *Termes* (=*Odontotermes* of some authors) and (*Macrotermes* (then included under *Termes*). Haviland (1898) reported *Microcerotermes* (then included under *Eutermes* s. lat.). The studies of Oshima (1914, 1916, 1917, 1920) have added six genera to the list. In the second note in this series (1921) five genera were added, one of which I now consider a subgenus. The three genera and one subgenus reported for the first time in this note bring the total to sixteen genera and two subgenera.

In addition to the numerous collections which I have been able to make in Luzon, Cebu, Negros, and Leyte, I have to thank Mr. R. C. McGregor, Dr. Edward H. Taylor, Dr. A. W. Herre, and many of my former pupils in the University of the Philippines for collections from many parts of the Archipelago. The resulting collection includes specimens from more than two thousand colonies from many regions in the Islands, from the Batanes to Jolo, from seacoast and lowland plain to mountain top. I feel justified in the belief, therefore, that these eighteen genera and subgenera represent all which occur in any considerable numbers and that few, if any, genera will be added by future collecting, although the number of species will be

considerably increased. A list of the genera and subgenera of Philippine termites and working keys for their identification are given below.

In the list of genera it will be noted that several of the subgenera of Holmgren are considered to be of generic rank, while *Planocryptotermes* Light and my new *Havilanditermes* are considered to be subgenera. My action in these cases is based chiefly on the presence or absence of known, distinct, differential characters in the alates and is purely tentative in view of the need of a thorough revision of the genera of termites.

An examination of the type material of *Termitogetonella* Oshima, for access to which I have to thank Doctor Oshima, showed that it was based on a collection of *Termes dives* soldiers with a *Prorhinotermes* adult. *Termitogetonella* therefore becomes a synonym of *Prorhinotermes*. *Heterotermes* Froggatt (1896) must replace the more familiar *Leucotermes* Silvestri (Emerson, 1925). The nasute Philippine species which Oshima considered to belong in Holmgren's subgenera *Ceylonitermes, Rotunditermes, Trinervitermes,* and *Grallatotermes* are seen on comparison with type material clearly to fall in Holmgren's *Eutermes* s. str. now replaced by *Nasutitermes* Banks (1920). Therefore, the first three have no place in a list of Philippine genera, and the last is included because of the report in this note of the presence of a true *Grallatotermes* species in the Islands.

List of genera and subgenera of Philippine termites.

Family KALOTERMITIDÆ.

1. Genus *Kalotermes* Hagen s. str. N. Banks.
2. Genus *Neotermes* Holmgren.
3. Genus *Cryptotermes* N. Banks s. str.
4. Genus *Cryptotermes* subgenus *Planocryptotermes* Light.
5. Genus *Glyptotermes* Froggatt.

Family RHINOTERMITIDÆ.

6. Genus *Heterotermes* Froggatt (= *Leucotermes* Silvestri).
7. Genus *Prorhinotermes* Silvestri. (*Termitogetonella* Oshima is a synonym of *Prorhinotermes* as pointed out above.)
8. Genus *Coptotermes* Wasmann.
9. Genus *Schedorhinotermes* Silvestri (= *Rhinotermes* as used by Oshima).

Family TERMITIDÆ.

10. Genus *Macrotermes* Holmgren (= *Termes* ex parte as used by Oshima).
11. Genus *Termes* Linnæus, s. str. N. Banks (= *Odontotermes* as used by Oshima).

12. Genus *Nasutitermes* N. Banks s. str. (= subgenus *Eutermes* s. str. Holmgren). (Oshima's species referred to *Ceylonitermes*, *Grallatotermes*, *Trinervitermes*, and *Rotunditermes* belong in *Nasutitermes*, as will be brought out in later papers.)
13. Genus *Nasutitermes* subgenus *Havilanditermes* subg. nov.
14. Genus *Grallatotermes* Holmgren nec Oshima. (Oshima's species referred to "*Eutermes* (*Grallatotermes*)" belong to *Nasutitermes* s. str. as will be brought out in later papers.)
15. Genus *Lacessititermes* Holmgren.
16. Genus *Hospitalitermes* Holmgren.
17. Genus *Capritermes* Wasmann.
18. Genus *Microcerotermes* Wasmann.

Two keys are given, one based on the characters of the winged imago and the other on characters of the soldier. Worker characters do not present a satisfactory basis for a key at present, although it is hoped that further study may provide sufficiently definite characters for such a key, since it is the workers that are most commonly encountered. The characters used are based upon Philippine species only and do not necessarily apply to the species of these genera occurring elsewhere.

Practical keys to the genera and subgenera of Philippine termites.

I. BASED ON IMAGO CHARACTERS

a^1. No fontanel (family Kalotermitidæ).
  b^1. Radial sector with numerous branches to the anterior wing margin (Plate 1, fig. 2).
    c^1. Media does not join the radial sector.
      d^1. Media is not heavily chitinized and lies parallel to and intermediate between the radial sector and the cubitus (Plate 1, fig. 5) .... 1. Genus *Kalotermes* Hagen, s. str. N. Banks.
      d^2. Media is heavily chitinized and lies parallel to and near the radial sector (Plate 1, fig. 1) .... 2. Genus *Neotermes* Holmgren.
    c^2. Media joins the radial sector near or beyond the center of the wing.
      d^1. Smaller, head 0.8 millimeter wide.
3. Genus *Cryptotermes* N. Banks.
      d^2. Larger, head 1 millimeter or more in width.
4. Genus *Cryptotermes* subgenus *Planocryptotermes* Light.
  b^2. Radial sector without branches (Plate 1, fig. 3).
5. Genus *Glyptotermes* Froggatt.
a^2. Fontanel present (families Rhinotermitidæ and Termitidæ).
  b^1. Anterior wing scale much larger than the posterior which it overlaps (Plate 3, fig. 2, Light, 1921*b*); mandibles of the *Leucotermes* (*Heterotermes*) type (family Rhinotermitidæ).
    c^1. Clypeus conspicuously swollen (Plate 3, fig. 2, Light, 1921*b*).
      d^1. Dark species; the clypeus produced, directed forward, and marked by a distinct median groove.
6. Genus *Schedorhinotermes* Silvestri.

d^2. Light species; clypeus swollen but not produced and without a distinct median groove........ 7. Genus *Prorhinotermes* Silvestri.

c^2. Clypeus not swollen, usually flat.

d^1. Ocelli lacking; antennæ with 15 to 17 segments.
8. Genus *Heterotermes* Froggatt.

d^2. Ocelli present; antennæ with 18 to 23 segments.
9. Genus *Coptotermes* Wasmann.

b^2. Anterior wing scale never overlapping posterior wing scale; mandibles not of "*Leucotermes* type" (family Termitidæ).

c^1. Very large forms, considerably more than 20 millimeters long with the wings.

d^1. Wings clear brown; segment III of antennæ as large as II.
10. Genus *Macrotermes* Holmgren.

d^2. Wings smoky brown; segment III of antennæ smaller than II.
11. Genus *Termes* Linnæus s. str. (= *Odontotermes* Holmgren).

c^2. Medium-sized to small forms, never more than 20 millimeters long with the wings.

d^1. All tibiæ with two apical spines. (Genera with nasute soldiers, formerly grouped in genus *Eutermes*.)

e^1. Smaller, rarely more than 15 millimeters in length with wings or 8 millimeters without wings; postclypeus typically much lighter than frons.
12. Genus *Nasutitermes* N. Banks = *Eutermes* s. str. Holmgren.

e^2. Larger, usually more than 16 millimeters long with the wings and 9 millimeters without the wings; postclypeus little if any lighter than the frons.

f^1. Segment III of the antennæ little if any longer than II.

g^1. Fontanel large, three-cornered. (Based on description; no Philippine alates taken.)
13. Subgenus *Havilanditermes* subg. nov.

g^2. Fontanel small, very narrow, in form of crevice.

h^1. Fontanel distinct, white; ocelli large, projecting; head strongly haired.... 14. Genus *Grallatotermes* Holmgren.

h^2. Fontanel indistinct; ocelli small, more or less flat; head weakly haired.... 15. Genus *Lacessititermes* Holmgren.

f^2. Segment III of antennæ twice as long as segment II.
16. Genus *Hospitalitermes* Holmgren.

d^2. Fore tibiæ with three apical spines.

e^1. Head broad-oval; first tooth of mandible much larger than second .... 17. Genus *Capritermes* Wasmann.

e^2. Head elongated, parallel-sided; first two teeth of mandible about equal .... 18. Genus *Microcerotermes* Wasmann.

II. BASED ON SOLDIER CHARACTERS

a^1. No fontanel; pronotum broader than the head (Plate 1, Light, 1921*b*) (family Kalotermitidæ).

b^1. Head reddish or reddish brown; mostly large species; that is, head more than 1.5 millimeters broad (smaller in *Kalotermes taylori* sp. nov).

c^1. Pronotum longer than one-half its breadth (Plate 5, fig. 7); femora more or less dilated................ 1. Genus *Kalotermes* Hagen s. str.

c^2. Pronotum shorter than one-half its breadth (Plate 5, fig. 2); femora little if any dilated.................... 2. Genus *Neotermes* Holmgren.

b^2. Head smoky brown to black, never distinctly reddish; small to very small species; that is, head less than 1.5 millimeters broad.

c^1. Head short, truncated, with an anterior concavity (Plate 2, Light, 1921*b*).

d^1. Head high, rough; anterior concavity deep; mandibles small, weakly toothed (Plate 2, fig. 1, Light, 1921*b*).
3. Genus *Cryptotermes* N. Banks s. str.

d^2. Head low, smooth, broad, and flat; anterior concavity shallow; mandibles fairly large, distinctly toothed (Plate 2, fig. 3, Light, 1921*b*).
4. Genus *Cryptotermes* subgenus *Planocryptotermes* Light.

c^2. Head elongated, not strongly truncate and without any anterior concavity (Plate 3, fig. 4)........ 5. Genus *Glyptotermes* Froggatt.

a^2. Fontanel present; pronotum narrower than the head (families Rhinotermitidæ and Termitidæ).

b^1. Pronotum flat (Plate 3, fig. 1, Light, 1921*b*) (family Rhinotermitidæ).

c^1. Labrum normal in length, not greatly elongated; a single soldier caste or, if two, soldiers not differing greatly in size and form.

d^1. Fontanel in normal position without tubular elongation (Plate 3, fig. 1, Light, 1921*b*).

e^1. Head elongated, parallel-sided; no groove from the fontanel; labrum with needle-shaped tip (Plate 4, Light, 1921*b*).
6. Genus *Heterotermes* Froggatt.

e^2. Head broad-oval, narrowed anteriorly; labrum without needle-shaped tip; a groove running forward from the fontanel.
7. Genus *Prorhinotermes* Silvestri.

d^2. Fontanel opening far in front with a short tubular elongation.
8. Genus *Coptotermes* Wasmann.

c^2. Labrum greatly elongated with a bilobed tip; two soldier castes differing widely in size and form.
9. Genus *Schedorhinotermes* Silvestri.

b^2. Pronotum saddle-shaped with an uplifted anterior region (Plate 8, fig. 1) (Family Termitidæ).

c^1. Antennæ with 17 segments; mandibles normal.

d^1. Larger species; soldiers of two widely different sizes; mandibles untoothed. (The mound-building termites of the Philippines.)
10. Genus *Macrotermes* Holmgren.

d^2. Smaller species; soldiers of one size; a tooth on the left mandible and a rudimentary tooth on the right mandible.
11. Genus *Termes* Linnæus s. str.

c^2. Antennæ with 11 to 15 segments or, when more, the mandibles are twisted.

d^1. Soldiers nasute; that is, head drawn out into a long rostrum with fontanel opening at its tip (Plate 6, fig. 2).

e^1. Usually small and with short antennæ; if larger, never with long antennæ............ 12. Genus *Nasutitermes* N. Banks s. str.

e^2. Larger species with elongated antennæ (Plate 6, fig. 6).

f^1. Head but little produced behind and but little depressed (Plate 6, fig. 2).

13. Genus *Nasutitermes* subgenus *Havilanditermes* subg. nov.

f^2. Head greatly produced behind and greatly depressed (Plate 6, fig. 4).

g^1. Rostrum short and thick; legs moderately elongated; hind femora considerably shorter than the abdomen.

14. Genus *Grallatotermes* Holmgren.

g^2. Rostrum long (Plate 6, fig. 5) or shorter and very slender; legs greatly elongated; hind femora as long as or longer than the abdomen.

h^1. Rostrum long, rather thick at base; segment III of antennæ shorter than IV.

15. Genus *Lacessititermes* Holmgren.

h^2. Rostrum short, slender; segment III of antennæ longer than IV............ 16. Genus *Hospitalitermes* Holmgren.

d^2. Head normal, not nasute.

e^1. Mandibles twisted................ 17. Genus *Capritermes* Wasmann.

e^2. Mandibles normal........ 18. Genus *Microcerotermes* Wasmann.

A list of the known species of Philippine termites follows. This list supersedes that given in my first note (1921). Where the name that I consider to be correct differs from the one given by the original describer or reporter, its equivalent in the former list is given below.

1. *Kalotermes mcgregori* Light, 1921.
2. *Kalotermes taylori* sp. nov.
3. *Neotermes malatensis* Oshima.
   Calotermes (Neotermes) malatensis Oshima, 1917.
4. *Neotermes lagunaensis* Oshima.
   Calotermes (Neotermes) lagunaensis Oshima, 1920. This will probably prove to be merely an extreme variant of *N. malatensis*.
5. *Neotermes parviscutatus* sp. nov.
6. *Neotermes microphthalmus* sp. nov.
7. *Cryptotermes cynocephalus* Light, 1921.
8. *Cryptotermes (Planocryptotermes) nocens* Light.
   Planocryptotermes nocens Light, 1921.
9. *Glyptotermes chapmani* sp. nov.
10. *Prorhinotermes luzonensis* Light, 1921.
   ? *Termitogetonella tibiaoensis* Oshima, 1920, alates.
11. *Prorhinotermes gracilis* Light, 1921.
   Probably a synonym of *P. luzonensis*, based on the nanitic forms of a young colony.
12. *Heterotermes philippinensis* Light.
   Leucotermes philippinensis Light, 1921.
13. *Coptotermes flavicephalus* Oshima, 1914.
14. *Coptotermes vastator* Light, 1929.
   Coptotermes travians (Haviland), Oshima, 1920.
   Coptotermes formosanus (Shiraki), Oshima, 1920.

15. *Schedorhinotermes bidentatus* Oshima.
    Rhinotermes (*Schedorhinotermes*) *bidentatus* Oshima, 1920.
16. *Schedorhinotermes longirostris* (Brauer).
    Rhinotermes (*Schedorhinotermes*) *longirostris* (Brauer), Oshima, 1916.
17. *Schedorhinotermes tarakensis* Oshima, 1914.
    Rhinotermes (*Schedorhinotermes*) *tarakensis* Oshima, 1920.
18. *Termes dives* Hagen, 1858.
    Odontotermes mediodentatus Oshima, 1920.
    Termitogetonella tibiaoensis Oshima, 1920, soldiers and workers.
19. *Macrotermes gilvus* Hagen.
    Termes gilvus Hagen, 1858.
    Termes (*Termes*) *copelandi* Oshima, 1914.
    Termes (*Macrotermes*) *luzonensis* Oshima, 1914.
    Termes (*Macrotermes*) *manilanus* Oshima, 1914.
    Termes (*Macrotermes*) *philippinensis* Oshima, 1914.
20. *Nasutitermes balintauacensis* Oshima.
    Eutermes (*Eutermes*) *balintauacensis* Oshima, 1917.
21. *Nasutitermes castaneus* Oshima.
    Eutermes (*Eutermes*) *castaneus* Oshima, 1916.
22. *Nasutitermes gracilis* Oshima.
    Eutermes (*Eutermes*) *gracilis* Oshima, 1916.
    Eutermes minutus Oshima, 1917 (fide Oshima, S. F. L.).
23. *Nasutitermes las-pinasensis* Oshima.
    Eutermes (*Eutermes*) *las-pinasensis* Oshima, 1920.
24. *Nasutitermes manilensis* Oshima.
    Eutermes (*Eutermes*) *manilensis* Oshima, 1916.
25. *Nasutitermes luzonicus* Oshima.
    Eutermes (*Grallatotermes*) *luzonicus* Oshima, 1914.
26. *Nasutitermes panayensis* Oshima.
    Eutermes (*Grallatotermes*) *panayensis* Oshima, 1920.
27. *Nasutitermes mcgregori* Oshima.
    Eutermes (*Ceylonitermes*) *mcgregori* Oshima, 1916.
28. *Nasutitermes culasiensis* Oshima.
    Eutermes (*Rotunditermes*) *culasiensis* Oshima, 1920.
29. *Nasutitermes menadoensis* Oshima, 1914.
    Eutermes (*Trinervitermes*) *menadoensis* Oshima, 1920.
30. *Nasutitermes* (*Havilanditermes*) *atripennis* (Haviland), 1898.
    Reported here for first time from the Philippine Islands.
31. *Hospitalitermes hospitalis* (Haviland).
    Eutermes (*Hospitalitermes*) *hospitalis* Oshima, 1920.
32. *Hospitalitermes luzonensis* Oshima.
    Eutermes (*Hospitalitermes*) *luzonensis* Oshima, 1917.
33. *Hospitalitermes saraiensis* Oshima.
    Eutermes (*Hospitalitermes*) *saraiensis* Oshima, 1916.
34. *Grallatotermes admirabilus* sp. nov.
35. *Lacessititermes palawanensis* sp. nov.
36. *Microcerotermes distans* (Haviland), 1898.
37. *Microcerotermes los-bañosensis* Oshima, 1914.
38. *Capritermes paetensis* Oshima, 1920.

It seems very probable that careful studies of my extensive collections of *Nasutitermes*, *Hospitalitermes*, and *Schedorhinotermes* will reduce to synonymy some of the species described by Oshima. Numerous species remaining to be described in my collections, however, and the others certainly not as yet collected will, no doubt, considerably increase the total number of Philippine termite species.

DESCRIPTIONS AND DISCUSSIONS OF SPECIES

The descriptions here given are of a type that I have criticized (1927) but are presented in preliminary form with the expectation that future studies will bring out more clearly the important facts of proportion and range of variation. It is believed that the extensive illustrations will be of value to future workers in this difficult systematic field.

The species have been arranged in systematic order. In the genera *Kalotermes* and *Neotermes*, all the species which are represented in my collection, including the two previously known species and four new species, are described or discussed. The time seems opportune, therefore, for working keys to the species of these genera.

Key to the reproductive adults of Philippine Neotermes species.

a^1. Eye very small (compare figs. 1 and 3 of Plate 2), less than 0.45 millimeter in diameter, antennal segment III heavily chitinized, as long as II and twice as long as IV; hairs unusually long and bristlelike.
Neotermes microphthalmus sp. nov.

a^2. Eye larger (Plate 2, fig. 3), antennal segment III not conspicuously chitinized, less than twice as long as IV; hairs shorter.

b^1. Larger, head more than 1.8 millimeters wide.
Neotermes parviscutatus sp. nov.

b^2. Smaller, head about 1.5 millimeters wide.
Neotermes malatensis Oshima.

The reproductive adult is unknown for *Kalotermes taylori* sp. nov. For that of *K. mcgregori* Light see below.

Key to the soldiers of Philippine species of Kalotermes and Neotermes.

a^1. Pronotum long, deeply bilobed anteriorly (Plate 5, fig. 7), overhanging the posterior margin of the head................................ Genus *Kalotermes*.

b^1. Small, head narrow in proportion to length, less than 1.25 millimeters wide .... *Kalotermes taylori* sp. nov.

b^2. Larger, head broader in proportion, more than 1.6 millimeters wide.
Kalotermes mcgregori Light.

a^2. Pronotum short, weakly concave in front, not bilobed (Plate 5, fig. 2).
Genus *Neotermes*.

b^1. Pronotum weak and small, much narrower than head (Plate 3, fig. 7).
Neotermes parviscutatus sp. nov.

b^2. Pronotum as wide as the head.

c^1. Head rather narrow in proportion to length, mandibles straight except at tips (Plate 3, fig. 1)...... *Neotermes malatensis* Oshima.

c^2. Head broader, mandibles more curved (Plate 3, fig. 5).

d^1. Hairing abundant, eye present, labrum much broader than long, posterior margin of pronotum straight.
Neotermes grandis sp. nov.

d^2. Hairing sparse, eye absent, labrum longer than broad, posterior margin of pronotum obscurely bilobed.
Neotermes lagunaensis Oshima.

The soldier of *Neotermes microphthalmus* sp. nov. is unknown.

KALOTERMES MCGREGORI Light, 1921. Plate 1, fig. 5; Plate 2, fig. 4; Plate 3, fig. 2; Plate 4, fig. 1; Plate 5, figs. 1 and 13.

Kalotermes mcgregori LIGHT, Philip. Journ. Sci. 19 (1921) 30–36, pl. 1, figs. 1 and 2, text fig. 1.

A collection (No. 584), made by J. W. Chapman and S. F. Light from the limb of a citrus tree in the mountains back of Dumaguete, Negros, in May, 1921, contains a single adult which, although somewhat damaged, shows that the two alates taken in Cebu (No. 534) and mentioned in a footnote to my second not on Philippine termites (1921*b*) belong to this species. A description is given below.

DIAGNOSIS

Adult.—General color light brown to yellow; head square, flattened above; antennæ of nineteen segments, III shorter than or equal to IV; median with numerous indistinct branches to the radial sector; cubitus with twelve to fourteen branches; subcosta of forewing extending for less than one-fourth of the wing length; radius of forewing extending for less than one-half the wing length, that of the hind wing more than one-half of length.

DESCRIPTION

Adult.—(Based on two alates of No. 534.) Dorsal surface brown to light yellow-brown; head red-brown distally, proximally clear brown; ventral surface pale yellow-brown to yellow; wings hyaline, costal veins light yellow distally to light brown in proximal area; head sparsely haired, body moderately.

Head (Plate 2, fig. 4) square (posterior to clypeal suture) and dorsally flattened; postclypeus broad and narrow and not clearly marked off behind; anteclypeus long, rhomboidal, white,

and with swollen labrum making head considerably longer than broad; labrum swollen but anteriorly depressed with a distal row of bristlelike hairs. Compound eyes rather flat with diameter equal to about one-half the distance from their posterior margins to posterior margin of head; ocelli low but distinct, rounded, approaching eye closely, their posterior borders in line with middle of eyes. Antennæ (Plate 2, fig. 4) slender; of nineteen segments, III to V small, III subequal to IV. Gulamentum shield-shaped, anterior margin weakly concave, sides rounding into strongly curved posterior border.

Pronotum large, considerably broader than head, and much longer than one-half its width, highest in middle, curving down to depressed lateral margins; anterior margin broadly but shallowly concave, sides convex, and posterior margin with shallow median concavity; shoulder spots dark brown, near anterior margin, one equidistant from the midline and lateral margin on each side; each at inner and deeper end of a groove which runs obliquely forward and outward; mesonotum and metanotum much smaller than pronotum; mesonotum narrower than metanotum; both with a median concavity, that of mesonotum very slight, that of metanotum distinct; each marked in its anterior portion by a slender, dark brown, median line.

Anterior wing scales large, covering anterior one-third of metanotum; wing (Plate 1, fig. 5) surfaces more or less mammalated, especially along lines of wing veins; median midway between radius sector and cubitus with numerous indistinct branches to the former in both fore and hind wing; median arising from radius sector well within membrane of hind wing but free throughout forewing; subcosta joining the costal margin in forewing within proximal one-quarter of wing membrane; radius joining costal margin well within proximal one-half of wing membrane; radial sector of forewing united to costal margin by five or six branches, proximal three very oblique, first arising proximal to the middle and joining costal margin beyond middle of wing membrane; cubitus with from twelve to fourteen branches; subcosta not separate within membrane of hind wing, but radius extending well beyond middle of wing membrane; radial sector of hind wing joined to costal margin by three or four branches.

Cerci short but distinct; styles sharp, slender, very closely approximated on midventral surface.

Measurements of alate male of Kalotermes mcgregori Light.

	mm.
Length with wings	14.0
Body length	8.2
Head length, to tip of labrum	1.80
Head length, to clypeal suture	1.35
Head width	1.53
Diameter of eye	0.45
Diameter of ocellus	0.18
Pronotum length	1.15
Pronotum width	1.80
Length of forewing	9.00
Width of forewing	3.24
Width of gulamentum	0.58
Length of gulamentum	0.63

Soldier.—(Plate 3, fig. 2; Plate 4, fig. 1; Plate 5, figs. 1 and 12.) For description see Light, 1921*b*.

KALOTERMES TAYLORI sp. nov. Plate 3, fig. 3; Plate 4, fig. 4; Plate 5, figs. 7 and 13.

DIAGNOSES

Adult.—Unknown; but from well-developed nymph, with wing pads 1.44 millimeters long, the following characters can be made out: Median midway between radial sector and cubitus; antennæ of seventeen or more segments; head at least 1.21 millimeters wide; pronotum broadly concave in front, weakly bilobed behind.

Soldier.—Small (5 millimeters long with the head); head long, rectangular; eyes distinct, pigmented; a minute, vertically elongated, hyaline spot above the eye; antennæ of thirteen or fourteen segments, III greatly enlarged and heavily chitinized; pronotum large, long, deeply bilobed; mesonotum and metanotum with well-developed wing pads.

DESCRIPTIONS

Adult.—Unknown; see diagnosis for characters derived from study of nymphs.

Soldier.—Head red-brown above, shading into yellow-brown on posterior and ventral surfaces and reddish black on frons; mandibles red-black, antennæ proximally red-brown, distally light yellow-brown; anterior region of pronotum reddish brown. Otherwise dorsal surface of thorax and abdomen dirty gray-brown; ventral surface paler, legs whitish.

Head (Plate 3, fig. 3) long, rectangular in dorsal view, slightly widest near posterior end; flat above with rounded postero-lateral corners, a convex posterior margin, and rounded lateral

surfaces; transverse suture visible, frons short and declivitous; dorsal rims of antennal foveolæ projecting. Eye large, circular, hyaline externally with an internal pigmented area about one-half the diameter of the outer hyaline area; separated from posterior margin of antennal foveola by about the diameter of the hyaline area; about the same distance above eye and slightly behind its center, a tiny, but conspicuous, vertically elongated, hyaline spot appears in the transverse suture.

Antennæ short, distally slender, but basally conspicuous because of the distinct enlargement and heavy chitinization of segment III (Plate 3, fig. 3); they consist of thirteen or fourteen segments, I and III large, II smaller but larger than the more distal segments; terminal segment much the smallest, narrow and oval; remaining distal segments more or less subequal; III enlarged, clavate, heavily chitinized, and hence conspicuous by its red color. Postclypeus not clearly demarcated, anteclypeus hyaline, labrum broader than long, somewhat swollen, broadest at the middle, sides and anterior margin convex. Mandibles more than one-half as long as head; the basal region not greatly swollen or roughened and without sharp line of demarcation; toothing as in Plate 4, fig. 4; outer half of untoothed portion of right mandible slightly but abruptly incurved, cutting margin of this untoothed distal region serrate. Gulamentum as in Plate 5, fig. 12.

Pronotum (Plate 5, fig. 7) very long and broad, broadest near the anterior end, very deeply bilobed anteriorly, the lobes broadly overlapping the posterior margin of the head, anterolateral corners rounded and produced laterally, sides receding into the faintly biconcave posterior margin.

Mesonotum and metanotum show distinct wing rudiments.

Head and body with inconspicuous coats of scattered, slender, light yellow hairs; styles slender, very closely approximated; cerci ventral and inconspicuous.

Measurements of soldier of Kalotermes taylori sp. nov.

	mm.
Length	4.50–5.00
Head with crossed mandibles	2.61
Head without mandibles	1.80
Head width	1.17
Length of left mandible	1.10
Pronotum width (in position)	1.30
Pronotum length, maximum	0.95
Pronotum length, minimum	0.72

Nymphs.—Those with developed wing pads (1.44 millimeters long) have eyes distinctly pigmented; antennæ of fifteen to seventeen segments; pronotum broadly concave in front, biconvex behind; head width (seventeen segments in antennæ), 1.21 millimeters; pronotum width, 1.15 millimeters; length, 0.65 millimeter.

Type locality.—Santa Cruz, Zamboanga, Mindanao, No. 1156; collected by E. H. Taylor, 8–IV–23. "In cut stump of hardwood."

NEOTERMES MALATENSIS (Oshima). Plate 1, figs. 1 and 7; Plate 2, figs. 3, 8, and 10; Plate 3, fig. 1; Plate 4, fig. 2; Plate 5, figs. 2, 5, and 10.

Kalotermes (*Neotermes*) *malatensis* Oshima, 1917.

Neotermes malatensis (Oshima), named for the district of Manila in which it was first collected by McGregor, is one of the commonest Philippine termites and is found widespread throughout the Archipelago. It lives in dead wood of living trees, builds no external structures, does not attack man's handiwork, and hence does not attract the attention received by the more conspicuous forms; such as, the builders of mounds (*Macrotermes*), the species that attack wooden structures from the ground (*Coptotermes*), or live in wooden structures and drop their fæcal pellets like sawdust from their workings (*Cryptotermes* and *Planocryptotermes*), or those that contrary to the ordinary habits of termites, come into the open and make extensive forays in search of food (*Hospitalitermes*).

Consistent examination, however, of dead branches on living cacauate, ipil-ipil, guava, or rain trees, or of the dead portion of trunks of living trees, or of the living portion of stubs or stumps will very shortly produce examples of this species.

The species exhibits great variation. My early incomplete collections produced several manuscript species which the present extensive collections show to represent variations due to the age of the colony; the nature, extent, and conditions of the wood containing the colony; and other, undetermined factors. For this reason, I consider it extremely probable that Oshima's *N. lagunaensis*, specimens of which I have examined but not studied carefully, represents one of the extremes of this variable species.

No series of measurements available is adequate to define the average or range for the various measurements and indices

of proportion for this species, but the following soldier measurements give some idea of the range:

Measurements of soldier of Neotermes malatensis (Oshima.)

	mm.
Body length (with head extended)	8.0–13.0
Head length with extended mandibles	4.0– 5.5
Head length to clypeofrontal suture	2.5– 3.7
Head width	1.8– 2.5
Pronotum width	1.8– 2.5
Pronotum length	0.7– 1.25

Second form queen of Neotermes malatensis (Oshima).—*No.* 483, Bulacan, Bulacan Province, Luzon; collected by Tansinsin, 5–IV–21. "In an orange tree."

General color, above, yellow with a brownish tinge, below, lighter. Head, pronotum, and other dorsal sclerites distinctly chitinized. Eye large, distinct, projecting, quite unpigmented, a tiny white spot above eye. Antennæ mutilated, but basal portion as in nymph. Median longitudinal light line and depression on thoracic nota distinct; small wing buds; abdomen short; otherwise as in nymph of species.

Three collections of *Neotermes* material stand out as quite beyond the known range of *N. malatensis,* extensive as that is, and it has seemed necessary to described them as new species.

NEOTERMES GRANDIS sp. nov. Plate 2, fig. 9; Plate 3, fig. 5; Plate 4, fig. 3; Plate 5, figs. 3 and 11.

DIAGNOSES

Adult.—Unknown.

Soldier.—Head large, thick, and broad; mandibles short and massive; antennæ with fifteen segments, III large, heavily chitinized, larger than II; II larger than IV or V and equal to VI; pronotum shorter than half its breadth, posterior margin straight; mesonotum and metanotum posteriorly weakly concave; thorax and abdomen broad and flat.

Nymphs.—Head and thorax white, abdomen dirty gray due to intestinal contents; hairs yellow-brown as in soldier; antennæ with fifteen segments, III obconic and as long as II; pronotum with distinctly concave anterior margin and sides receding into strongly convex posterior margin.

DESCRIPTIONS

Adult.—Unknown.

Soldier.—Dorsal surface of head shades from yellow-brown behind to red-brown in front, light yellow-brown below, darker at anterior end. Body pale transparent brown over opaque white, mottled with dirty gray areas seen through the body wall. Legs whitish.

Head, body, and legs with numerous brown hairs of various sizes, including a considerable number of long, bristlelike hairs.

Head (Plate 3, fig. 5) thick, broad, rectangular, flattened above and below; posterolateral corners broadly rounded, lateral surfaces rounded and rounding into the flat dorsal and ventral surfaces. Head suture distinct, frons declivitous with a broad, shallow, median depression.

Eye not raised above the surface, vertically elongate, externally hyaline, internally opaque white. Postclypeus not demarcated, anteclypeus very short and white. Labrum very small, much broader than long, its short sides rounding into the broadly convex anterior margin. Upper margins of antennal foveolæ slightly projecting, but much less so than in other species of the genus.

Mandibles (Plate 4, fig. 3) short and massive, not more than half as long as head; basal areas swollen and irregular, dark red-brown to reddish black, distal regions deep red-black to black; upcurved in their distal half, not strongly incurved; left mandible but slightly incurved and that at the extreme tip; teeth as in Plate 4, fig. 3; right mandible shorter than left, distally thicker, and much more incurved, the curved portion involving much more of its length; distal untoothed half of the mandible proper roughened on its medial surface; teeth as in Plate 4, fig. 3. Antennæ of fifteen segments, I largest, IV smallest, III next in size to I, III heavily chitinized and broader than the others except I; II larger than IV or V and equal to VI.

Pronotum (Plate 5, fig. 3) narrow and broad; when spread out, broader than head, considerably shorter than half its own width; anterior margin very weakly concave, sides convex in their anterior half and receding in posterior half; posterior margin almost straight; posterior margins of mesonotum and metanotum weakly concave.

Thorax and abdomen broad and flat; cerci small, styles long and slender.

Measurements of soldier of Neotermes grandis sp. nov.

	Smallest.	Largest.
Length	9.0	11.0
Head length with mandibles	4.22	4.95
Head length without mandibles (to the outer mandibular articulations)	2.88	3.15
Head width	2.34	2.61
Pronotum length in position	1.10	1.17
Pronotum width in position	2.34	......
Pronotum length spread	......	1.02
Pronotum width spread	2.52	......

Large nymphs.—Head and thorax whitish to faint yellow; abdomen dirty gray, due to intestinal contents; head and body with moderately numerous hairs whose yellow-brown color is in contrast to the generally whitish color of the body, particularly on the head and thorax; inner mandibular articulations marked by conspicuously dark spots; mandibles light yellow shading distally into dark red-brown.

Head (Plate 2, fig. 9) thick and nearly round in dorsal view; antennæ with fifteen plus segments, I and II cylindrical, III obconic (often showing imperfect division), IV to VI or VII more or less disk-shaped, I largest, III as long as II, IV very short, V to XI increasing in size, terminal segment narrow and oval.

Eye small and unpigmented, composed of few facets and difficult to see except in dissection.

Pronotum distinctly concave in front, convex behind, the sides receding posteriorly. The whole with the appearance of having been bent forward on either side from the midline.

Measurements of large nymph of Neotermes grandis sp. nov.

	mm.
Length	9.5
Head length	2.07
Head length to clypeofrontal suture	1.44
Head width	2.00
Pronotum width (in position)	1.93
Pronotum width (dissected)	2.16
Pronotum length	1.00

Type locality.—Mount Maquiling, Laguna Province, Luzon, No. 965; collected by E. H. Taylor, XII–22, at 700 meters altitude. "Tunnels in heart of living wood."

NEOTERMES PARVISCUTATUS sp. nov. Plate 1, fig. 8; Plate 2, fig. 6; Plate 3, fig. 7.

DIAGNOSES

Adult (*king and queen*).—Large, 11 to 12 millimeters long; head 2.16 millimeters wide; dark red-brown; thorax red-brown, abdomen yellow-brown; pronotum slightly concave, but not notched behind; sides rounding into both margins.

Soldier.—Head yellow, mandibles light yellow-brown proximally to reddish black distally; antennæ of twelve segments, III larger than II or IV, subequal to V; II smallest; labrum narrower at base than near distal end; pronotum very small, narrower than head, much less than half as long as wide; body narrow, especially narrowed in thoracic region, rounded, not flat.

DESCRIPTIONS

Adult.—Pronotum (Plate 1, fig. 8) with broadly concave anterior margin, projecting anterolateral corners and convex sides; posterolateral corners receding deeply to meet nearly straight posterior margin which is faintly concave near its center, but not notched; ends of pronotum appear as if bent forward in outer one-quarter; aside from these characters, and those given in the diagnosis, much as in *N. malatensis*.

Measurements of adults of Neotermes parviscutatus sp. nov.

	King.	Queen.
Body length	11.0	12.0
Head length, over all	2.34	2.34
Head length to clypeofrontal suture	1.82	1.82
Head width	2.16	2.16
Diameter of eye	0.64	0.64
Diameter of ocellus	0.27	0.27
Width of pronotum (in position)	2.34	2.34
Length of pronotum (in position)	1.24	1.24

Soldier.—Head (Plate 3, fig. 7) vaulted, bulging behind, narrowing towards the front, sides convex; sutures distinct; dorsal rim of antennal foveolæ projecting, upturned. Mandibles little if any upcurved; left with two teeth close together near tip; right with two widely separated teeth, the more distal one opposite the more proximal of left mandible; left more incurved than right, basal swelling large (Plate 3, fig. 7).

Eye represented by a narrow, vertically elongated, hyaline spot.

Pronotum very short, much narrower than head (Plate 3, fig. 7) and with broadly concave anterior margin and convex pos-

terior margin; sides strongly convex, rounding into anterior and posterior margins; mesonotum and metanotum much narrower than pronotum.

Measurements of soldier of Neotermes parviscutatus sp. nov.

	mm.
Length	8.00
Head length with mandibles	3.55
Head length without mandibles	2.16
Head width	1.93
Pronotum length	0.63
Pronotum width	1.62

Nymphs.—Small, largest less than 6 millimeters long; no sign of wing pads; head light yellow, body whitish yellow; head rounded behind, sides more or less parallel, bulging somewhat below the antennæ; antennæ of twelve or thirteen segments (eleven in very young specimens), segment I largest, II larger than III to VII, III small but larger than IV or V; IV very small, disk-shaped, often imperfectly demarcated from III; V two or three times as long as IV but shorter than long, VI about as long as wide, VII to next to last increasing in size; terminal segment smaller and narrow. Eyes faintly pigmented. Pronotum small and shaped as in soldier. Body as in soldier. Cerci conspicuous, styles long and slender.

Measurements of nymph of Neotermes parviscutatus sp. nov.

	mm.
Length	6.0
Head width	1.42
Head length	1.62
Head length to clypeofrontal suture	1.40
Pronotum width (in position)	1.20
Pronotum length	0.45

Type locality.—Mountains back of Dumaguete, Occidental Negros, Negros; Nos. 564 and 567; collected by J. W. Chapman and S. F. Light, 9–V–21; in a stump from other parts of which *Glyptotermes* and *Heterotermes* colonies were taken.

NEOTERMES MICROPHTHALMUS sp. nov. **Plate 1, figs. 2 and 9; Plate 2, figs. 1 and 7; Plate 5, fig. 6.**

DIAGNOSES

Adult.—Wings and dorsal surface dark brown; head wide (1.8 millimeters plus); eye small (0.41 millimeter in diameter);

antennæ of eighteen or nineteen segments, III about as long as II, twice as long as IV; hairs not numerous but long and bristlelike.

Nymphs.—Similar to those of *N. malatensis* and *N. grandis* but pronotum longer, more deeply concave in front and more convex behind.

Soldier.—Unknown.

DESCRIPTION

Adult.—Dark brown above, lighter brown below; anteromedian regions of mesonotum and metanotum white; wings dark brown; antennæ light, III dark, more heavily chitinized. Head (Plate 2, fig. 7) thick and blunt, eye small (Plate 2, fig. 1), antennæ of eighteen or nineteen segments (in some cases 18 on one side, 19 on the other), III large, heavily chitinized, as long as II, twice as long as IV. Pronotum (Plate 1, fig. 9) concave in front, biconvex behind, sides convex, receding posteriorly into posterior margin. Mandibles as in Plate 5, fig. 6. Wings strongly reticulate, heavily sculptured. Subcosta of forewing (Plate 1, fig. 2) joins costal margin considerably within proximal fourth of wing; radius joins costal margin within proximal half of wing; radial sector with seven or eight branches to costal margin; median at base of wing nearer cubitus but parallel to and near radial sector in rest of wing membrane, not quite so strongly chitinized as other veins of costal group, a few weak branches to radial sector, proximally short and simple, distally longer, more oblique, divided; cubitus with eight to eleven branches, several divided and distally with numerous minor connections to reticulation of wing membrane; subcosta of hind wing not separate; radius joining at about same point as in forewing with relation to branch of radial sector, but actually beyond middle of wing; radial sector and median united for some distance (1.8 millimeters) within wing membrane; radial sector with five plus branches to costal membrane; connections between median and radial sector and median and cubitus as in forewing, cubitus by an extensive reticulation in which appear semblances at places of a vein midway between them; cubitus with nine main branches and several minor distal ones to the reticulation.

Measurements of alate of Neotermes microphthalmus sp. nov.

	mm.
Length with wings	17.0
Length	8.0
Head width	1.90
Pronotum length	1.00
Pronotum width	2.07
Length of hind wing	14.1
Width of hind wing	4.1

Type locality.—Horns of Negros, above Dumaguete, Negros, No. 102; collected by J. W. Chapman, 24–IV–18, at 100 meters elevation.

GLYPTOTERMES CHAPMANI sp. nov. Plate 1, figs. 3, 4, 6, and 10; Plate 2, figs. 2 and 5; Plate 3, figs. 4 and 6; Plate 4, fig. 5; Plate 5, figs. 4, 8, 9, and 14.

MATERIAL EXAMINED

No. 546 (Leyte 5), a complete nest series taken by Light from a lauan log lying on the beach just above high-tide level, near Quiot, Leyte, May 1, 1921. The type (alate female), the allotype (alate male), and the morphotypes (soldiers and nymphs) are from this colony. Paratypes in my collection and in the United States National Museum.

No. 581 (Negros 35), a complete nest series taken by Chapman and Light from a large colony in the stump of a jack tree, at an altitude of about 300 meters on the Horns of Negros, back of Dumaguete, Oriental Negros, May, 1921.

No. 558 (Negros 12), a young colony with but one soldier (mentioned under the discussion of variations) taken by Chapman and Light from a *Ficus* stump, at an altitude of about 500 meters on the Horns of Negros, May, 1921.

DIAGNOSES

Adult.—Very small, 7 millimeters or less in length with the wings and 4 millimeters or less without the wings; head with eyes less than 1 millimeter in breadth; generally dark brown except for the interscleritic membranes, the tibiæ, the tarsi, and the antennæ, which are white to light yellow. Antennæ of twelve segments, distal segments greatly enlarged; no T-shaped light area on the pronotum; cubitus and branches very indistinct; papillæ of cubitus and branches and the spaces between them evenly spaced.

Soldier.—Apparently but one size; head small, usually 1.5 millimeters or less in length (without mandibles) and 1 millimeter or less in breadth. Antennæ with eleven segments; left mandible with three conspicuous teeth of which the distal two are approximately equal and near together; right mandible with but one conspicuous tooth.

DESCRIPTIONS

Alate.—Head, thoracic and abdominal sclerites, coxæ, and femora dark brown; wing scales, bases of wings, and costal wing vein complex brown; remainder of wing membrane light brown; antennæ lighter; tibial spines and tarsal claws yellow; labrum, tibiæ, and tarsi yellowish white; spaces between the sclerites of thorax and abdomen dead white. Hairing sparse, consisting of scattered, long, spiny hairs and more numerous shorter hairs of varying size.

Head (Plate 2, figs. 2 and 5) slightly longer than broad, parallel-sided, slightly narrowed (without eyes) at level of eyes; anterolateral corners swollen, rounded posterolateral corners and posterior margin making together nearly a semicircle; sides nearly vertical; sutures fine but visible; transverse suture arcuate, running into anterior margins of ocelli. Labrum small, about as long as broad, posterior fourth overlapped by anteclypeus; anterior margin straight with a double row of hairs; posterior margin angularly convex. Anteclypeus trapezoidal, narrower and longer than the postclypeus (about one-third as long as wide), the anterior half overlapping the labrum. Postclypeus distinct from the frons but not clearly demarcated from anteclypeus except by color; broad and very short; darker (smoky) in the center with lighter lateral areas; central dark area longer than lateral areas. Mandibles as in Plate 5, fig. 9. Gulamentum about as long as wide with well-developed lateral lobes. Eyes on the vertical sides of head, small, somewhat elongated, projecting but little. Ocelli very small, separated from the eyes by less than half their width; nearest the eye somewhat behind its middle; elongated, egg-shaped, running into a point where continuous with the transverse suture; not strongly projecting (about one-third of eye projection), directed mediad and distad at an angle of about 45° to the long axis of head.

Antennæ (Plate 2, fig, 5) with twelve segments; II as long as III and IV together; IV often not completely separated, longer than III; III shortest and narrowest, V longer and wider than

III or IV, V to XI increasing in length and diameter; XII as long as XI but narrower and ovate.

Pronotum (Plate 1, fig. 10) with concave anterior margin; anterolateral corners very shortly rounded, sides receding to slightly convex posterior border which shows mere suggestion of a median concavity; posterolateral corners very broadly rounded; chitinous spots, marking points of attachments of lateral thoracic sclerites, are located very near anterior margin and at a point about midway between middle and posterolateral corners.

Wings extending far beyond tip of abdomen; wing membrane marked with rows of large papillæ (Plate 1, fig. 6) outlining wing veins and more or less regularly distributed in larger spaces between them; elsewhere than in costal area and basal portion of cubital area papillæ large, arranged in single rows separated by about two or three times basal diameters; papillæ inclined in direction of course of vein and tipped with brown giving to wing membrane its light brown color; papillæ much smaller on veins of costal area, brown all over and close-set; papillæ smaller and in double rows on basal three or four branches of cubitus; anterior margin of forewing and distal half of anterior margin of hind wing with short evenly spaced hairs, at considerable intervals, those near distal end of wing double. Wing veins very variable; forewing (Plate 1, fig. 3) with subcosta joining costal margin very near base of wing membrane; radius joining costal margin at a point about one-fifth the length of the wing membrane from suture; radial sector and media entering wing membrane close together, curving slightly downward to a point where most widely separated, then curving upward again, approaching very near one another and gradually approaching costal margin; from middle of wing the three costal veins very close together and equally spaced; two very imperfect vertical cross connections near tip of wing between radial sector and costal margin; another such cross connection still nearer tip, joining median and radial sector; cubitus entering wing membrane near radial sector and bending toward posterior border until separated from median by a space about twice the width of the costal complex and running thence parallel to that complex; cubitus with about twelve branches to margin, mostly unbranched and separated by from one to three rows of papillæ; first branch of cubitus entering from scale; first three or four branches in a darkened basal wing area and marked by tiny dark papillæ in approximately double

rows. Hind wing (Plate 1, fig. 4) without evident subcosta; radius poorly developed, joining costal margin in basal fifth of wing; radial sector and median united for from about one-fourth to as much as three-fourths of length of wing; a single separate anal very much thickened and with two short branches to margin; cubitus with branches much as in forewing.

Cerci two-jointed, basal joint broad and swollen; in the male, basal joint considerably more swollen than in the female.

Styles close together, long and slender and tipped with a long spinelike hair; lacking in the female.

Sixth sternum of female (seventh abdominal segment) much enlarged and projecting widely behind; wider than long or as wide as long.

Sixth sternum of male about size of fifth; seventh smaller than sixth; eighth much smaller, triangular, with the long, slender close-set styles at its apex.

Measurements of alate of Glyptotermes chapmani sp. nov.

	mm.
Length with wings	6.5–7.0
Length without wings	3.5–4.0
Wing length (forewing without scale)	5.0
Wing breadth	1.35
Head length	1.09
Head length to clypeus	0.9
Head width with eyes	0.9
Head width without eyes	0.8
Pronotum length	0.476
Pronotum width	0.88
Eye length	0.23
Eye breadth	0.19
Ocellus length	0.095
Ocellus breadth	0.057
Antennal segment III, length	0.057
Antennal segment III, breadth	0.057
Antennal segment XI, length	0.133
Antennal segment XI, breadth	0.095
Labrum length and breadth	0.30
Anteclypeus width	0.38
Anteclypeus length	0.135

Soldier.—Head pale smoky yellow or yellow-brown; mandibles red-black; other parts yellow; hairing sparse. Head (Plate 3, fig. 4) elongate, rectangular, slightly narrowed in the middle and somewhat wider at level of eyes; higher in front than behind; posterolateral corners rounded, posterior margin

slightly emarginate in the middle; sides curved (in transverse section); frons steeply declivitous from level of eyes, making an angle of about 45° with surface of head. Anterior border of elevated region of head with bilobed appearance due to a midlongitudinal depression first noticeable near anterior third of elevated region, broadening and deepening towards frons, and extending down frons as a broad, shallow median depression. Labrum about as long as wide, sides weakly convex, anterolateral corners bluntly rounded, anterior border straight, set with numerous spinelike hairs in two rows, the longest about half as long as labrum; labrum reaching to level of third (basal) tooth of left mandible; anteclypeus trapezoidal, nearly four times as wide as long; postclypeus narrow, more than four times as wide as long; mandibles (Plate 4, fig. 5) massive, tips very strongly and equally bent inward, left mandible with slenderer tip; three conspicuous subequal teeth on left mandible, two close together in distal half; right mandible with one conspicuous tooth at about its center; antennæ (Plate 3, fig. 6) of eleven segments, about one-half longer than mandibles; much as in the adult except segments with less increase in size towards tip; III shortest, XI longest; eye distinct, unpigmented, circular in outline, somewhat projecting, facets distinct; separated from posterior margin of antennal fossa by about once and a half its own diameter; gulamentum (Plate 5, fig. 14) with maximum width about twice that of narrowest portion.

Pronotum (Plate 5, fig. 4) much like that of alate but shorter and broader, considerably more than twice as broad as long; broadest just posterior to the anterolateral corners; lateral margins receding strongly; posterior margin weakly arcuate.

Measurements of soldiers of Glyptotermes chapmani sp. nov.

	mm.
Length with abdomen (head and mandibles extended)	7.0
Length with abdomen contracted, head bent, and mandibles crossed	4.0
Head length with mandibles extended	2.0–2.15
Head length without mandibles	1.4–1.5
Head width	0.9–1.03
Mandible length	0.68
Labrum length and breadth	0.22
Antennal length	1.08
Pronotum length	0.5
Pronotum width (dissected)	1.15
Gulamentum maximum width	0.27
Gulamentum minimum width	0.135

Nymph.—Whitish to whitish yellow except for darker margins to mandible and mandibular articulations and salmon pink color of abdomen, due to intestinal contents being visible through transparent body wall; wing pads of varying sizes; head very broadly egg-shaped; eyes unpigmented (in nymphs with small wing pads), scarcely projecting; pronotum shaped as in adult; abdomen large; antennæ with twelve segments, III showing more or less imperfectly division into III and IV of adult.

Measurements of nymphs of Glyptotermes chapmani sp. nov.

	mm.
Length	5.0–6.5
Head length	1.1–1.35
Head width	1.0–1.01

Variation.—Wide variations are found in the wing venation. The most important of these are (1) a tendency on the part of the "cubitus" to send off a large anterior branch lying more or less intermediate between the ordinary position of the cubitus and that of the "median," (2) a tendency for the whole cubitus, in abnormal wings, to run anteriorly and be connected with the costal complex, (3) the tendency toward very extended union of "radial sector" and "median" in the hind wing. These conditions all lead me to suspect that a study of the nymphal wings of this species and of other species of this genus, and perhaps of other genera of the family Kalotermitidæ, may show the vein long known as the "median" to be in reality the posteriormost branch of the radius ($R_{4, 5}$) and that media is here ordinarily united with the cubitus.

Soldiers and nymphs of young colonies, such as No. 558, are smaller, lighter colored, and have fewer antennal segments than those of more-mature colonies, and the soldier head is quite atypical. As the first workers and soldiers are necessarily fed by the adults and develop under conditions generally less favorable than those of the fully functioning colony, it is to be expected that they will be smaller and less perfect than the later more carefully fed and cared-for soldiers and workers or nymphs. These conditions call for the exercise of the greatest care to avoid the erection of species based on such atypical nanitic individuals from young colonies.

Systematic position.—This very distinct species of *Glyptotermes* is, next to *G. dentatus* Haviland, the smallest of the known Oriental species of the genus. The most nearly related species seem to be the two nearest geographically, as would be

expected, *G. dentatus* Haviland of Borneo and *G. fuscus* Oshima of Formosa, the Loo Choo Islands, and the Bonin Islands.

A comparison with the alate individuals of the latter included in a collection of Japanese termites kindly sent me by the College of Science of the Imperial University of Tokyo at the request of Dr. S. Hozawa, shows the present species to differ most strikingly in its smaller size and in the very different papillation of its wings. The papillæ of the wing membrane of *G. fuscus* Oshima are much more numerous, more closely set in general, more irregularly placed, and so arranged as to leave a clear area on either side of the cubitus and its branches, thus distinctly marking the course of these veins which in *G. chapmani* are very difficult to make out because of the even spacing of the papillæ on and between the veins.

The soldiers of *G. chapmani* sp. nov. differ distinctly from those of *G. fuscus* Oshima in their smaller size and in the shape and dentition of the mandibles. The mandibles of the soldier of *G. fuscus* are bent throughout, while those of *G. chapmani* are bent only near the tips. The dentition differs, among other points, in that the two distal teeth of the left mandible of *G. fuscus* are directed distally with a short anterior and a long posterior face, while those of *G. chapmani* are directed mediad with anterior and posterior faces of equal length. The antennæ of the soldier of *G. fuscus* that I have before me show twelve segments with III and IV somewhat incompletely separated; I have found no indication of a twelfth segment in *G. chapmani,* in which III and IV are incompletely separated in the 11-segmented antennæ.

For the characters of *G. dentatus* Haviland I must rely upon the descriptions of Haviland and Holmgren. The adult is known only from the description given by Haviland, which seems to indicate the following differences between the two species: (1) There are eleven segments in the antennæ of *G. dentatus* adults and twelve in those of *G. chapmani.* This is a very uncertain distinction, as it may simply mean an incomplete separation of III and IV in Haviland's specimens. (2) The wings of *G. dentatus* are considerably smaller than those of *G. chapmani.* (3) The ocellus in *G. dentatus* is "in contact with the eye," while in *G. chapmani* it approaches the eye but is separated from it by nearly half its diameter. (4) The "ventral plate of the seventh abdominal segment (of the female) is nearly as broad as long" in *G. dentatus*, while in *G. chapmani* it is fully as broad as long or broader.

Differences between the soldiers of *G. dentatus* and those of *G. chapmani* based on Holmgren's description of the former are as follows: (1) The labrum of *G. chapmani* is shorter, not extending over one-half of the extended mandibles; (2) the toothing of the mandible is different; among other points, the two distal teeth of the left mandible are equal in size in *G. chapmani* and apparently unequal in *G. dentatus*. *Glyptotermes dentatus* Haviland and *G. chapmani* sp. nov. are apparently closely related species, and a comparison of large series of Bornean and Philippine specimens may even show them to be more closely related than the present data indicate.

Biology.—This species seems to prefer fallen logs and dead standing stumps to the dead portions of living trees. Of the three colonies collected, one was in a fallen lauan log, one in a stump of a tree (jack tree) which had been cut down, and the third in the stump of a tree (*Ficus*) blown down in a storm, leaving a dying stump.

The two adult colonies were found to contain large numbers of fully adult, darkly pigmented alate forms in May when the collections were made, and it seems probable that they would have emerged soon after that time. The Leyte colony was a large one and was found in small tunnels and chambers all through the large log of lauan which they inhabited. In life the bodies of the soldiers and nymphs have much the same size, color, and general appearance. The adults were always accompanied by nymphs of various sizes, but never by soldiers. Soldiers were few and where found were nearly always in twos.

Genus GRALLATOTERMES Holmgren

Eutermes, subgenus *Grallatotermes* Holmgren 1912.
Termes, subgenus *Eutermes* Desneux 1905, ex parte (*T. grallator*).
Not *Eutermes* (*Grallatotermes*) Oshima 1914, 1916, 1917, and 1920.

This interesting termite genus has been known, hitherto, only from the soldiers and workers of *Termes grallator* collected on Graget Island by Biro in 1901 and described by Desneux in 1905. The discovery of a generically related but specifically quite distinct species in the southern islands of the Philippine Archipelago (Panay, Negros, and Mindanao) is of peculiar interest in connection with the study of ancient land bridges and routes of floral and faunal migration. It may be predicted that collections in Celebes will produce one or more connecting species, since this would seem to be the only possible distribution route which would allow for the presence of species of such a

distinct type of limited distribution in both New Guinea and the Philippines.

It seems probable that the restriction of the genus to the mountains of Panay and Negros is due to the retreat of the virgin forest in these two islands, while in the Cotabato region of Mindanao the original forests approach the coast line and are still to be found on the lowlands.

GRALLATOTERMES ADMIRABILUS sp. nov. Plate 6, figs. 3, 4, and 7; Plate 7, figs. 5 to 8; Plate 8, figs. 1, 4, 6, 7, and 14.

DIAGNOSES

Imago.—Head black, median areas of thoracic sterna, legs, and distal segments of antennæ yellow; other parts light or dark brown; clypeus lighter than frons, about one-fourth as long as broad; segment III of antennæ as long as II or slightly shorter; fontanel distinct, white, a three-rayed fissure; ocelli white, conspicuous, separated from eye by less than their short diameter; eyes very large and projecting; costal stripe inconspicuous, separated by narrow white line from thickened radial sector.

Soldier.—Bicolored, thorax and legs bright yellow, other parts black to black-brown; head with rostrum, 1.71 millimeters long; head, 1.2 millimeters wide.

Workers.—Two castes, color as in soldier; head width, 1.4 millimeters in large worker and 1.04 millimeters in small worker.

DESCRIPTIONS

Imago.—Head black; abdominal terga, lateral areas of abdominal sterna, anterolateral and anterior regions of pronotum, three proximal segments of antennæ, anterior margin of mesonotum and metanotum, and veins of proximal portion of wing dark brown; median region of pronotum, mesonota, and metanota (with the exception of their anterior margins), and lateral thoracic sclerites light brown; median areas of thoracic sterna, legs, and distal segments of antennæ yellow; wings somewhat opaque yellow-brown, between Ridgway's Mars yellow and Sudan brown; costal veins distally opaque yellow, proximally dark brown; other veins thickened and darkened in proximal half of wing, inconspicuous distally.

Head (Plate 7, fig. 8) rounded behind, longer than wide (exclusive of eyes), shape masked by very large, laterally placed, projecting eyes; frons elevated between eyes with declivitous sides bearing the large, white, conspicuous ocelli; ocelli elongated

in long axis of body, lemon-shaped, separated from the eyes by less than half their short diameter; fontanel (Plate 7, fig. 8) conspicuous, white, nearly as long as ocellus, narrow, slitlike, with raylike extensions along the transverse sutures; frons with median longitudinal sunken area in region of fontanel; antennæ of fifteen segments, I large, cylindrical, as long as II and III together; III usually slightly shorter than II; IV, V, VI, and VII subequal and shorter than III, distal segments longer, VIII to XIII increasingly clavate, XIV and XV long oval, XV shorter and narrower than XIV.

Postclypeus very short, less than one-fourth as long as its maximum width, swollen; posterior margin somewhat convex, anterior margin much shorter, strongly concave, lateral margins strongly converging anteriorly; anteclypeus narrow, white; labrum light yellow, shorter than broad, nearly semicircular. Head with numerous very light-colored hairs, scattered longer hairs, and numerous short recurved hairs.

Pronotum with weakly concave anterior margin, faintly notched in the center; anterolateral corners very broadly rounded, lateral margins receding rapidly into the narrow, biconvex, and centrally notched posterior margin; with numerous white or pale yellow hairs; median two-thirds of anterior margin uplifted; anterior margins of mesonotum and metanotum weakly concave, anterolateral corners of mesonotum deeply notched, posterior margins of mesonotum and metanotum concave, posterolateral corners sharp, somewhat produced.

Wings covered throughout by tiny, close-set projections, which, seen in high magnification, are stellate; distal half of wing membrane with small weak hairs on both surfaces increasingly numerous towards the tip; costal margin and tip marked by a heavy fringe of hairs which becomes less marked as it runs onto anal margin of wing; hairs decreasing in length and number towards proximal fifth of wing, proximal to which they are lacking; radius running onto forewing membrane for a short distance where it is much closer to costal than to radial sector; median free in forewing, arising from radial sector in hind wing; running near and parallel to cubitus with one to three branches or rarely unbranched; cubitus with nine to twelve branches, first six or seven thickened throughout or at least distally, proximal one or two arising within wing scale; radial sector bordered posteriorly in proximal half of wing by dark brown, thickened area which broadens distally, becomes dirty yellow, and spreads to both sides of vein; distally this thickened

area has numerous connections with costal, particularly in forewing; in middle and distal regions of wing, its sinuosities are closely followed posteriorly by a narrow white line that separates it from an inconspicuous light yellow costal stripe which is very faint in the hind wing.

Abdomen of female considerably larger than that of male; posterior sterna lighter than in the male; seventh sternum very long; cerci with broad bases and slender distal regions; styli not observed.

Measurements of alate imago of Grallatotermes admirabilus sp. nov.

	mm.
Length with wings	18 (male), 19–21 (female)
Body length	9.0 (male), 10 (female)
Length of forewing	15.2–16.2
Length of forewing with scale	17.0
Head width with eyes	1.90
Head width between eyes	1.08
Head length	1.80
Head length to clypeofrontal suture	1.20–1.25
Width of postclypeus (maximum)	0.76–0.8
Diameter of compound eyes	0.72
Length of ocellus	0.225
Length of fontanel	0.16
Length of pronotum	0.97–1.0
Width of pronotum	1.8

Soldier.—Head black, with reddish tinge; thorax and legs bright yellow; abdominal terga dark, black-brown; antennæ dark brown with lighter tips; underside of head and mouth parts shading from brown to light yellow; abdominal sterna light transparent yellow through which are seen the opaque white fat bodies and the darker alimentary canal.

Head (Plate 6, figs. 3 and 4) somewhat broadly pear-shaped, flatly rounded behind, sides converging anteriorly; posterior portion of head produced (that is, extending far behind the neck), rounded and uplifted; head distinctly concave in dorsal profile; rostrum (text fig. 1, *a*) short, thick, conical, arising by a very broad base from the otherwise declivitous frons; dorsal surface of rostrum very weakly concave, ventral surface strongly concave; rostrum making an angle of about 40° with the horizontal when head rests on its ventral surface; distal third of rostrum with dark reddish color, ending in an abruptly narrowed hyaline tip surrounded by four (three?) anteriorly directed, bristlelike

hairs. Antennæ (Plate 6, figs. 3 and 4) long, considerably longer than head and rostrum; of thirteen segments, III longest, II and XIII shortest; II little more than half as long as III; IV shorter than V, VI, VII, or VIII, which are subequal and little shorter than III; IX to XIII increasingly short and narrow, XIII ovate, the others clavate; in some specimens III shows a basal swelling, seeming to foreshadow division. Mandibles (Plate 8, fig. 4; text fig. 1, *b*) with conspicuous, yellow-brown, untoothed apical portion and broad, rounded, untoothed, basal portion; labrum as in Plate 8, fig. 6.

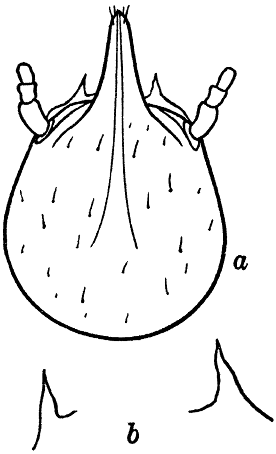

FIG. 1. *Grallatotermes admirabilus* sp. nov., soldier; *a*, head, from above, × 26; *b*, mandibles, × 55.

Pronotum (Plate 8, fig. 1) short; uplifted region short, low, and set off by grooves on the surface, not by marginal notches, and with entire anterior margin; posterior margin with faint median notch. Legs long (Plate 8, fig. 14), weakly haired; mesothoracic legs longer than prothoracic and metathoracic legs much longer than either; tibia of hind leg as long as the abdomen. Thorax practically hairless; abdominal terga with single row of short hairs on posterior margin, sterna with a similar row of much longer hairs and covered with many shorter hairs; cerci prominent.

Measurements of soldier of Grallatotermes admirabilus sp. nov.

	mm.
Body length	4.5–5.5
Head length to posterior margin of antennal foveola	1.17
Head with rostrum	1.71
Head width	1.20
Pronotum width	0.74
Pronotum length	0.38
Length of hind femur	1.62
Length of hind tibia	2.07

Large worker.—Color as in soldier; head long-oval, sides rounding imperceptibly into the rounded posterior margin; sutures very distinct; fontanel as in adult, region about fontanel sunken; labrum as in Plate 7, fig. 6; postclypeus short, about three times as broad as long, swollen; anterior border concave,

posterior strongly convex; frons behind postclypeus sunken; anteclypeus large, white, as long as postclypeus; gulamentum and labium as in Plate 8, fig. 7. Antennæ (Plate 6, fig. 7) lighter and shorter than in soldier, 14-segmented; II and III subequal, IV shortest; an irregular white area on posterior border of antennal fossa perhaps representing an eyespot. Thorax slender and low; abdomen thick, domed above and flat below giving it a humped appearance; hairing as in soldier with head hairs more numerous.

Measurements of large worker of Grallatotermes admirabilus sp. nov.

	mm.
Body length	5.0–5.5
Head length	1.70
Head length to clypeofrontal suture	1.125
Head width	1.40
Pronotum width	0.864
Pronotum length	0.54

Small worker.—Like the large worker but much smaller (Plate 7, figs. 5 and 7).

Measurements of small worker of Grallatotermes admirabilus sp. nov.

	mm.
Body length	3.5
Head length	1.26
Head length to clypeofrontal suture	0.81
Head width	1.035
Pronotum width	0.65
Pronotum length	0.45

Type locality.—Horns of Negros, above Dumaguete, Negros, No. 571; collected by J. W. Chapman and S. F. Light, 11–V–21.

Collections of Grallatotermes admirabilus sp. nov. examined.

No.	Locality.	Collector.	Date.	Castes.
Oshima's collection	Panay, Culasi	McGregor	July 7, 1918	Soldiers, large workers, small workers.
571, type	Negros, above Dumaguete.	Chapman and Light.	May 11, 1921	Adults, soldiers, large workers, small workers.
943	do	Herre	March 15, 1922	Soldiers, large workers, small workers.
1142	Mindanao, Suab River on the Cotabato coast.	Taylor	April 25, 1923	Adults, soldiers, large workers, small workers.
1186	do	do	April 25, 1923	Do.

Systematic position.—Through the kindness of Mr. W. W. Froggatt, whose work on Australian termites is well known, and Dr. Nils Holmgren, both of whom sent me specimens of *Grallatotermes grallator* from the type collections, it has been possible to compare the workers and the soldiers of the two species. The most striking difference is in the coloration, the conspicuously bicolored *G. admirabilus* contrasting sharply with the more uniformly colored *G. grallator.* The brilliant yellow thoracic nota of the former species are especially in contrast with the dark nota of the latter. The soldier of the new species is distinctly larger than that of *G. grallator,* and the worker of *G. grallator* is intermediate in size between the two worker castes of *G. admirabilus.* It seems probable, however, that more-complete collections of *G. grallator* will produce workers of two sizes of which the one here referred to is the larger. Other differences are found in the relative lengths of the antennal segments, etc.

Biology.—This remarkable termite builds a large carton nest on a tree trunk as reported by McGregor for Panay and the author for Negros. In both these localities it was taken at an elevation of 600 meters. The nest discovered by Chapman and Light was about 4 feet above the ground on the rootlets of a a large *Ficus* tree. There is no record of the presence of covered ways. However, there is no direct evidence that this is a day-foraging species, although the long legs, the heavy chitinization and pigmentation, and the peculiar color scheme, which do not seem suited to a purely cryptobiotic existence, all point in this direction.

Genus NASUTITERMES N. Banks

Subgenus HAVILANDITERMES [1] novum

Eutermes, subgenus *Eutermes* s. str. Holmgren ex parte.
Termes, atripennis section Haviland ex parte.

DIAGNOSES

Imago.[2]—Dark brown; wings brown-black, very thickly haired; fontanel large, three-cornered; ocelli separated from eye by their short diameter or more; postclypeus very short, much shorter than half its width; antennæ 15-segmented, III about as

[1] Named in honor of Mr. G. D. Haviland in commemoration of his basic work on the termites of the Oriental and African regions.

[2] Based on Holmgren's description of *Eutermes atripennis* Haviland.

long as II; pronotum nearly triangular, relatively short with strongly converging sides.

Soldier.[3]—Two intergrading sizes. Head large, light brownish yellow; rostrum long, thick, conical, distally reddish brown, darker than head; antennæ rather long, of fourteen segments, III shorter than IV and as long as II or somewhat shorter; mandibles prominent, left with a rudimentary tooth near the tip; legs rather long but hind tibia considerably shorter than abdomen; legs, thorax, and underside of abdomen yellow; dorsal surface of abdomen brown, antennæ light brown.

Large worker.—Color much as in soldier; antennæ of fifteen segments.

Small worker.—Much smaller, lighter and less heavily chitinized than the large worker; antennæ of fourteen segments.

Type species, *Termes atripennis* Haviland.

NASUTITERMES (HAVILANDITERMES) ATRIPENNIS (Haviland).

Termes atripennis Haviland.

DESCRIPTIONS

Imago.—Not represented in my collections.

Soldier.—Head and antennæ light brownish yellow, somewhat browner than Ridgway's raw sienna; rostrum darker distally, red-brown; thoracic nota light brown; dorsal surface of abdomen dark brown; other parts yellow. Head (Plate 6, figs. 1 and 2) large, produced but little (that is, projecting posteriorly but little behind the neck); as seen from above, broader than long (to the base of the rostrum); rostrum longer than head; head slightly sunken at point of origin of rostrum which is somewhat elevated, making the dorsal profile distinctly concave; sides of head strongly convex, posterior margin less so; head of smaller soldiers but little shorter and much narrower. Antennæ (Plate 6, figs. 1 and 2) 14-segmented; II cylindrical and slightly shorter than III which is obconic; IV about as long as III but much thicker; V somewhat shorter and narrower than IV or VI; VII to XII subequal in length; IV to VIII with increasingly slender bases, the more-distal segments with very narrow bases; XIII somewhat narrower and more ovate; XIV a short narrow oval. Rostrum long, thick, conical, outer portion nearly cylindrical, somewhat uplifted (that is, making an angle of about 20° with the plane of the ventral surface of the head). Head sunken at point of dorsal junction of rostrum with head

[3] Based on Holmgren's description of *E. atripennis* and on the soldiers of Philippine collections.

(Plate 6, fig. 2), giving a distinctly concave dorsal profile. Rostrum abruptly narrowed distally to form a slender hyaline tip; cephalic gland shown by magnification as a large light area in occipital region, its duct as a light line with dark borders. Mandibles (Plate 8, fig. 10) yellow, apical portion prominent; a rudimentary tooth near the tip of left mandible. Legs (Plate 8, fig. 13) rather long, hind tibia about two-thirds as long as abdomen which is distinctly humped. Hairing in general weak; head with only a very few, scattered, microscopic hairs; a number of hairs of varying size on distal end of rostrum; pronotum (Plate 8, fig. 2) with very short hairs in the anterior region, but thorax otherwise practically hairless; abdomen dorsally naked except for a few microscopic hairs at posterior margins of terga, ventrally with a row of long, slender, yellow hairs near posterior margin and more-numerous, scattered, smaller, white hairs.

Measurements of soldier of Nasutitermes (Havilanditermes) atripennis (Haviland).

	Large soldier.	Small soldier.
	mm.	mm.
Body length	5.2	4.3
Head length to posterior margin of antennal foveola	1.17	1.08
Head length with rostrum	2.18	2.03
Head width	1.30	1.12
Pronotum length	0.27	......
Pronotum width	0.63	......
Length of hind tibia	1.80	1.75
Length of abdomen	2.70	2.43

Large worker.—Color scheme as in soldier, head yellow-brown, thoracic nota lighter brown and abdominal terga dark smoky brown. Head (Plate 7, fig. 2) sutures very distinct, fontanel prominent, triangular; postclypeus short, about one-fourth as long as wide; anteclypeus prominent, anterior margin projecting in center; mandibles as in Plate 8, fig. 5. Antennæ (Plate 7, fig. 2) of fifteen segments; III shortest and very narrow, II not quite as long as III plus IV; segments distal to IV broader, suborbicular to broad oval. Head and dorsal surface of body sparsely haired with exception of anterior elevated region of pronotum; ventral surface and legs more liberally supplied with brownish yellow hairs. Anterior elevated region of pronotum set off by distinct notches, nearly vertical in position; anterior margin notched in center, posterior margin of pronotum entire.

Measurements of large worker of Nasutitermes (Havilanditermes) atripennis (Haviland).

	mm.
Length	6.0
Head width	1.64
Head length to tip of labrum	1.95
Pronotum width	0.82
Pronotum length (in position)	0.44

Small worker.—(Plate 7, fig. 3). Little smaller than large worker, similar in shape; color much lighter; head, antennæ, and sclerites of dorsal surface of body yellow; antennæ with fourteen segments, with an imperfectly divided segment III, thus representing fifteen segments.

Measurements of small worker of Nasutitermes (Havilanditermes) atripennis (Haviland).

	mm.
Length	4.5–5.00
Head width	1.42
Head length to tip of labrum	1.78

Collections of Nasutitermes (Havilanditermes) atripennis (Haviland) examined.

No.	Locality.	Collector.	Date.	Castes.
963	Luzon, Laguna, Mount Maquiling	Taylor	December, 1922	Soldiers and workers.
1000	Tablas, Odiongon	do	January, 1923	Do.
1147	Mindanao, Cotabato, Milbuk	do	March or April, 1923	Do.

Our knowledge of the distribution and habits of this interesting species, known heretofore only from Haviland's description (Borneo), is very meager. It has been taken by E. H. Taylor in three Philippine localities at an elevation of 780 meters on Mount Maquiling, on Tablas Island, and at Milbuk on the Cotabato coast. Taylor's notes report it as taken "under bark of living tree, in earthen runways and in earth near base of tree" (Cotabato), "in rotting wood" (Mount Maquiling), and "under a rotten log" (Tablas). These notes indicate, as would have been expected from its light color, that in spite of its long legs this is not a day forager.

Genus LACESSITITERMES Holmgren

Eutermes (*Lacessititermes*) Holmgren.

LACESSITITERMES PALAWANENSIS sp. nov. Plate 6, figs. 5 and 6; Plate 7, figs. 1 and 4; Plate 8, figs. 3, 8, 9, 11, and 12.

DIAGNOSES

Imago.—Ocelli separated from eye by more than long diameter; pronotum 0.88 millimeter long, longer than half its width; fontanel small and indistinct; segment III of antenna longer than IV.

Soldier.—Head, with rostrum, and body very dark, black-brown; head about 2 millimeters long and 1.09 millimeters wide; antennal segment III nearly half again as long as II.

DESCRIPTIONS

Imago.—Dark, head black-brown, postclypeus brown, anteclypeus hyaline, labrum yellow; antennæ, palpi, and outer leg joints light yellow-brown; pronotum anteriorly edged with black, rest yellow-brown; wing scales edged with black-brown; thoracic sclerites brown; basal leg sclerites and terga and sterna dark brown.

Head circular behind, eyes medium, projecting; ocelli small, separated from eyes by more than long diameter; fontanel small, indistinct, yellowish, narrow, does not extend to transverse suture which is marked in center by short transverse white spot; antennal segment II smallest; III longer than IV but less than twice as long as II; pronotum broadest just behind anterior margin, sides straight, receding strongly to narrow straight posterior margin.

Measurements of queen of Lacessititermes palawanensis sp. nov.

	mm.
Head length	2.015
Head length to postclypeus	1.38
Head width with eyes	1.75
Ocellus, long diameter	0.23
Fontanel length	0.13
Eye diameter	0.525
Distance between inner margins of eyes	1.425
Length of antennal segment I	0.235
Length of antennal segment II	0.15
Length of antennal segment III	0.215
Pronotum length	0.885
Pronotum width	1.4631

Soldier.—Head and rostrum very dark black-brown, thoracic nota and abdominal terga dark black-brown, other thoracic sclerites, cervical sclerites, ventral region of head, and region about antennal foveola, palpi, basal joints of antennæ, coxæ, and femora of legs, and sterna lighter smoky brown; region about mouth, distal portion of antennæ, and trochanters lighter. Head (Plate 6, figs. 5 and 6) much produced and uplifted behind; rostrum long, conical, meeting head at a considerable angle, uplifted; head profile deeply concave. Distal portion of each mandible in form of a long spine (Plate 8, fig. 8). Antennæ very long, with fourteen segments; II shortest, III nearly twice as long as II, about as long as I (which is very thick) and shorter than IV; V and VI increasingly long; VII to IX longest, X to XIII decreasing in length; XIII about as long as IV; XIV much shorter, about as long as III; thickness of bases of segments decreasing towards the tip. Thoracic nota marked by a median light line; pronotum (Plate 8, fig. 3) with a small notch in center of anterior and posterior margin; mesonotum and metanotum with notch in posterior margin only. Body long and slender; legs long (Plate 8, fig. 12); hind femora reaching nearly to end of abdomen; hind tibia longer than femora.

Measurements of soldier of Lacessititermes palawanensis sp. nov.

	mm.
Length with head	4.51
Length without head	2.65
Head length	1.99
Head to constriction	0.8
Head to rostrum	1.165
Rostrum length	0.83
Head width (maximum)	1.09
Head width (minimum anterior)	0.60
Length of antennal segment II	0.133
Length of antennal segment III	0.19
Length of antennal segment IV	0.235
Length of antennal segment VIII	0.4
Rostrum width at base	0.225
Rostrum width at tip	0.113
Pronotum width	0.60
Pronotum length	0.263
Mesonotum width	0.48
Mesonotum length	0.27
Metanotum width	0.555
Metanotum length	0.2175
Hind tibia	2.33
Hind femur	1.91

Large worker.—Head black-brown; thoracic nota, terga, coxæ, and femora dark smoky brown; antennæ lighter brown, palpi still lighter; tibiæ and tarsi yellow with faint brownish tinge; labrum and trochanters yellow. Head (Plate 7, fig. 4) long, more or less pentagonal, widest at level of antennæ, sides receding thence to round into weakly convex posterior margin; long suture conspicuous, transverse sutures distinct in central part of head, obscure laterally; fontanel large, elongated, somewhat triangular; a conspicuous white spot on the posterior ventral margin of the antennal foveola in the line of the transverse suture has the appearance of an "eye." Antennæ with fifteen segments, III longer than II and slightly longer than IV; XIII and XIV longest, obconic, with slender bases; XV long oval. Mandibles as in Plate 8, fig. 11. Thoracic nota with median white line, unnotched or very faintly so; head with scattered, very tiny hairs and a very few (6 or 8) large hairs; postclypeus much shorter than half its width, much swollen, particularly in the center; frons deeply sunken behind postclypeus.

Measurements of large worker of Lacessititermes palawanensis sp. nov.

	mm.
Length with head	5.49
Length without head	4.25
Head length to tip of labrum	1.78
Head width	1.43
Head length to postclypeus	1.16
Fontanel length	0.17
Postclypeus length	0.21
Postclypeus width	0.53
Pronotum width	0.79

Small worker.—Smaller, lighter, less heavily chitinized (Plate 7, fig. 1); segments III and VI of antennæ shorter than II or V; III lightest, narrowest, and shortest; otherwise as in large worker.

Measurements of small worker of Lacessititermes palawanensis sp. nov.

	mm.
Length with head	4.43
Length without head	3.27
Head width	1.2
Head length	1.32
Head to postclypeus	0.975
Fontanel	0.188
Postclypeus length	0.18
Postclypeus width	0.375

Reproductive nymphs.—Smoky black, wings well developed; antennæ with fifteen segments; mandibles as in Plate 8, fig. 9.

Type locality.—Iwahig, Palawan, No. 1263; collected by E. H. Taylor, X–23.

Biology.—This large, dark, long-legged, heavily chitinized species is obviously equipped for day-foraging and Taylor's notes, "found in small, very light, paper nests built in small shrubs or rattan, *without paper tunnels above or below the nests,*" indicate the same. It was found on Thumb Peak, near Iwahig, Palawan, occurring to above an elevation of 1,500 meters.

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ILLUSTRATIONS

[All illustrations are reproductions of unretouched photomicrographs made from dissections mounted in celloidin in balsam. Wings were stained with methylene blue to bring out the venation. The magnifications are approximations.]

PLATE 1

All figures of Plate 1 represent wings or pronota of alates of the subfamily Kalotermitinæ.

FIG. 1. *Neotermes malatensis* Oshima, forewing, × 6.5. (Collection No. 797.)
2. *Neotermes microphthalmus* sp. nov., forewing, × 5. (Collection No. 102.)
3. *Glyptotermes chapmani* sp. nov., forewing, × 15. (Collection No. 581.)
4. *Glyptotermes chapmani* sp. nov., hind wing, × 15. (Collection No. 581.)
5. *Kalotermes mcgregori* Light, forewing, × 6.5. (Collection No. 534.)
6. *Glyptotermes chapmani* sp. nov., distal half of hind wing, × 40.5. (Collection No. 581.)
7. *Neotermes malatensis* Oshima, pronotum, × 15. (Collection No. 797.)
8. *Neotermes parviscutatus* sp. nov., pronotum, × 15. (Collection No. 564.)
9. *Neotermes microphthalmus* sp. nov., pronotum, × 15. (Collection No. 102.)
10. *Glyptotermes chapmani* sp. nov., pronotum, × 37.5. (Collection No. 581.)

PLATE 2

FIG. 1. *Neotermes microphthalmus* sp. nov., compound eye of alate, × 22.5. (Collection No. 102.)
2. *Glyptotermes chapmani* sp. nov., head of alate, × 15. (Collection No. 581.)
3. *Neotermes malatensis* Oshima, compound eye of alate, × 22.5. (Collection No. 797.)
4. *Kalotermes mcgregori* Light, head of alate, × 15. (Collection No. 534.)
5. *Glyptotermes chapmani* sp. nov., head of alate, × 20. (Collection No. 581.)
6. *Neotermes parviscutatis* sp. nov., head of alate, × 12.5. (Collection No. 564.)
7. *Neotermes microphthalmus* sp. nov., head of alate, × 15. (Collection No. 102.)

FIG. 8. *Neotermes malatensis* Oshima, head of alate, × 15. (Collection No. 797.)
9. *Neotermes grandis* sp. nov., head of nymph, × 15. (Collection No. 965.)
10. *Neotermes malatensis* Oshima, head of nymph, × 15. (Collection No. 797.)

PLATE 3

FIG. 1. *Neotermes malatensis* Oshima, head of soldier, × 12.5. (Collection No. 797.)
2. *Kalotermes mcgregori* Light, head of soldier, × 12.5. (Collection No. 339.)
3. *Kalotermes taylori* sp. nov., head of soldier, × 15. (Collection No. 1156.)
4. *Glyptotermes chapmani* sp. nov., head of soldier, × 20. (Collection No. 581.)
5. *Neotermes grandis* sp. nov., head of soldier, × 15. (Collection No. 965.)
6. *Glyptotermes chapmani* sp. nov., antenna of soldier, × 25. (Collection No. 581.)
7. *Neotermes parviscutatus* sp. nov., whole mount of soldier, × 10. (Collection No. 564.)

PLATE 4

Mandibles of soldiers of Kalotermitinæ. All were photographed from the ventral surface and hence the mandibles, right and left, are reversed in position.

FIG. 1. *Kalotermes mcgregori* Light, × 25. (Collection No. 339.)
2. *Neotermes malatensis* Oshima, × 25. (Collection No. 797.)
3. *Neotermes grandis* sp. nov., × 25. (Collection No. 965.)
4. *Kalotermes taylori* sp. nov., × 25. (Collection No. 1156.)
5. *Glyptotermes chapmani* sp. nov., × 25. (Collection No. 581.)

PLATE 5

FIG. 1. *Kalotermes mcgregori* Light, pronotum of soldier, × 15. (Collection No. 339.)
2. *Neotermes malatensis* Oshima, pronotum of soldier, × 13.5. (Collection No. 797.)
3. *Neotermes grandis* sp. nov., pronotum of soldier, × 15. (Collection No. 965.)
4. *Glyptotermes chapmani* sp. nov., pronotum of soldier, × 37.5. (Collection No. 581.)
5. *Neotermes malatensis* Oshima, mandibles of alate, × 40.5. (Collection No. 797.)
6. *Neotermes microphthalmus* sp. nov., mandibles of alate, × 12.5. (Collection No. 102.)
7. *Kalotermes taylori* sp. nov., pronotum of soldier, × 15. (Collection No. 1156.)
8. *Glyptotermes chapmani* sp. nov., foreleg of alate, × 67.5. (Collection No. 581.)
9. *Glyptotermes chapmani* sp. nov., mandibles of alate, × 71.5. (Collection No. 581.)

FIG. 10. *Neotermes malatensis* Oshima, gulamentum and labium of soldier, × 15. (Collection No. 797.)

11. *Neotermes grandis* sp. nov., gulamentum and labium of soldier, × 15. (Collection No. 965.)
12. *Kalotermes mcgregori* Light, gulamentum of soldier, × 15. (Collection No. 339.)
13. *Kalotermes taylori* sp. nov., gulamentum of soldier, × 15. (Collection No. 1156.)
14. *Glyptotermes chapmani* sp. nov., gulamentum and labium of soldier, × 15. (Collection No. 581.)

PLATE 6

FIG. 1. *Havilanditermes atripennis* (Haviland), head of soldier in dorsal view, × 18. (Collection No. 963.)

2. *Havilanditermes atripennis* (Haviland), head of soldier in lateral view, × 18. (Collection No. 963.)
3. *Grallatotermes admirabilus* sp. nov., head of soldier in dorsal view, × 22.5. (Collection No. 571.)
4. *Grallatotermes admirabilus* sp. nov., head of soldier in lateral view, × 25. (Collection No. 571.)
5. *Lacessititermes palawanensis* sp. nov., head of soldier in lateral view, × 18. (Collection No. 1263.)
6. *Lacessititermes palawanensis* sp. nov., head of soldier in dorsal view, × 18. (Collection No. 1263.)
7. *Grallatotermes admirabilus* sp. nov., antenna and fragment of head capsule of large worker, × 43. (Collection No. 571.)

PLATE 7

FIG. 1. *Lacessititermes palawanensis* sp. nov., head of small worker, × 18. (Collection No. 1263.)

2. *Havilanditermes atripennis* (Haviland), head of large worker, × 18. (Collection No. 963.)
3. *Havilanditermes atripennis* (Haviland), head of small worker, × 18. (Collection No. 963.)
4. *Lacessititermes palawanensis* sp. nov., head of large worker, × 18. (Collection No. 1263.)
5. *Grallatotermes admirabilus* sp. nov., heal of small worker, × 25. (Collection No. 571.)
6. *Grallatotermes admirabilus* sp. nov., labrum of large worker, × 40.5. (Collection No. 571.)
7. *Grallatotermes admirabilus* sp. nov., labrum of small worker, × 40.5. (Collection No. 571.)
8. *Grallatotermes admirabilus* sp. nov., head of alate to show very large compound eyes and fontanel, × 20. (Collection No. 571.)

PLATE 8

FIG. 1. *Grallatotermes admirabilus* sp. nov., pronotum of soldier, × 47.5. (Collection No. 571.)

2. *Havilanditermes atripennis* (Haviland), pronotum of soldier, × 47.5. (Collection No. 963.)
3. *Lacessititermes palawanensis* sp. nov., pronotum of soldier, × 47.5. (Collection No. 1263.)

FIG. 4. *Grallatotermes admirabilus* sp. nov., mandibles of soldier, × 47.5. (Collection No. 571.)

5. *Havilanditermes atripennis* (Haviland), mandibles of large worker, × 27. (Collection No. 963.)

6. *Grallatotermes admirabilus* sp. nov., labrum of soldier, × 149. (Collection No. 571.)

7. *Grallatotermes admirabilus* sp. nov., gulamentum and labium of large worker, × 45. (Collection No. 571.)

8. *Lacessititermes palawanensis* sp. nov., mandibles of soldier, × 47.5. (Collection No. 1263.)

9. *Lacessititermes palawanensis* sp. nov., mandibles of nymph, × 25. (Collection No. 1263.)

10. *Havilanditermes atripennis* (Haviland), mandibles of soldier, × 47.5. (Collection No. 963.)

11. *Lacessititermes palawanensis* sp. nov., mandibles of large worker, × 25. (Collection No. 1263.)

12. *Lacessititermes palawanensis* sp. nov., hind leg of soldier, × 16.5. (Collection No. 1263.)

13. *Havilanditermes atripennis* (Haviland), hind leg of soldier, × 16.5. (Collection No. 963.)

14. *Grallatotermes admirabilus* sp. nov., foreleg of soldier, × 16.5. (Collection No. 571.)

TEXT FIGURE

FIG. 1. *Grallatotermes admirabilus* sp. nov., soldier; *a*, head, from above, × 26; *b*, mandibles, × 55.

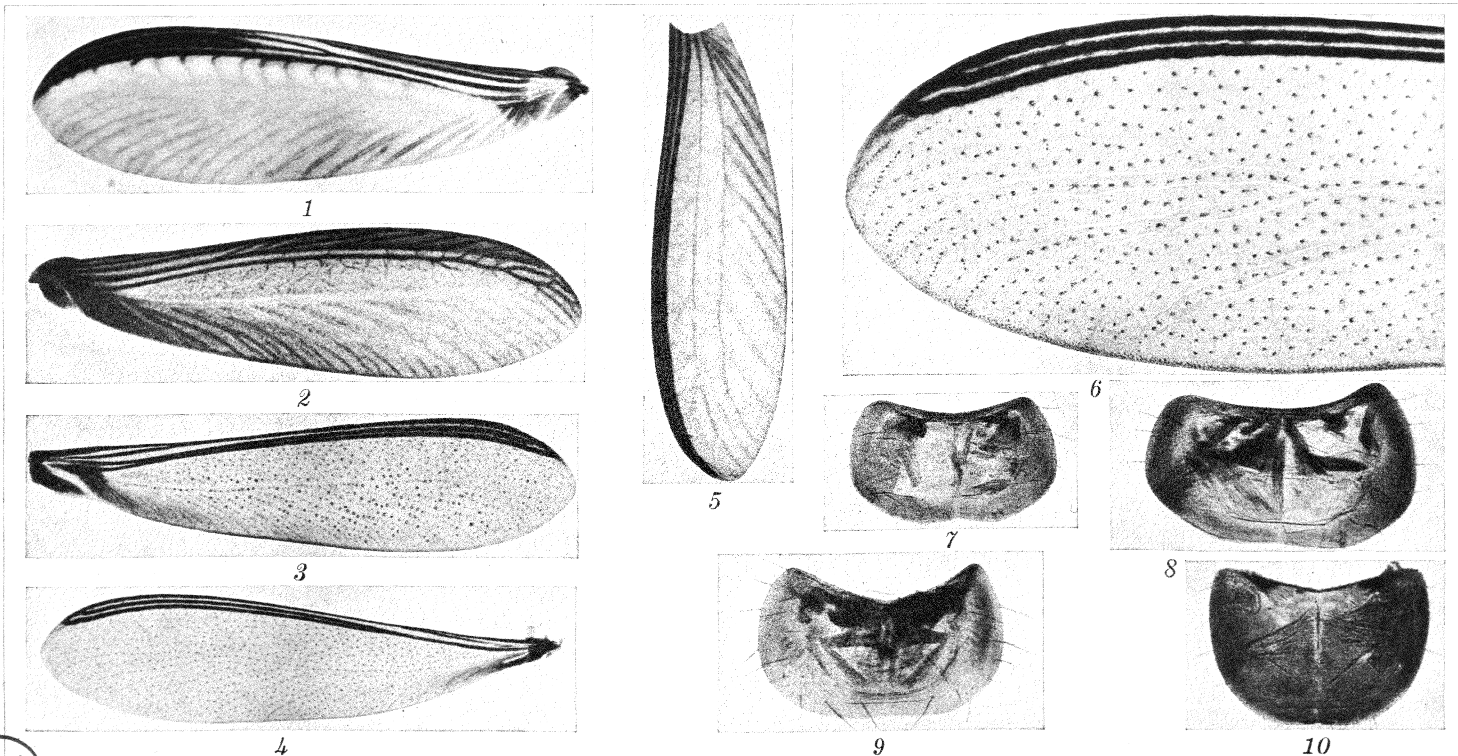
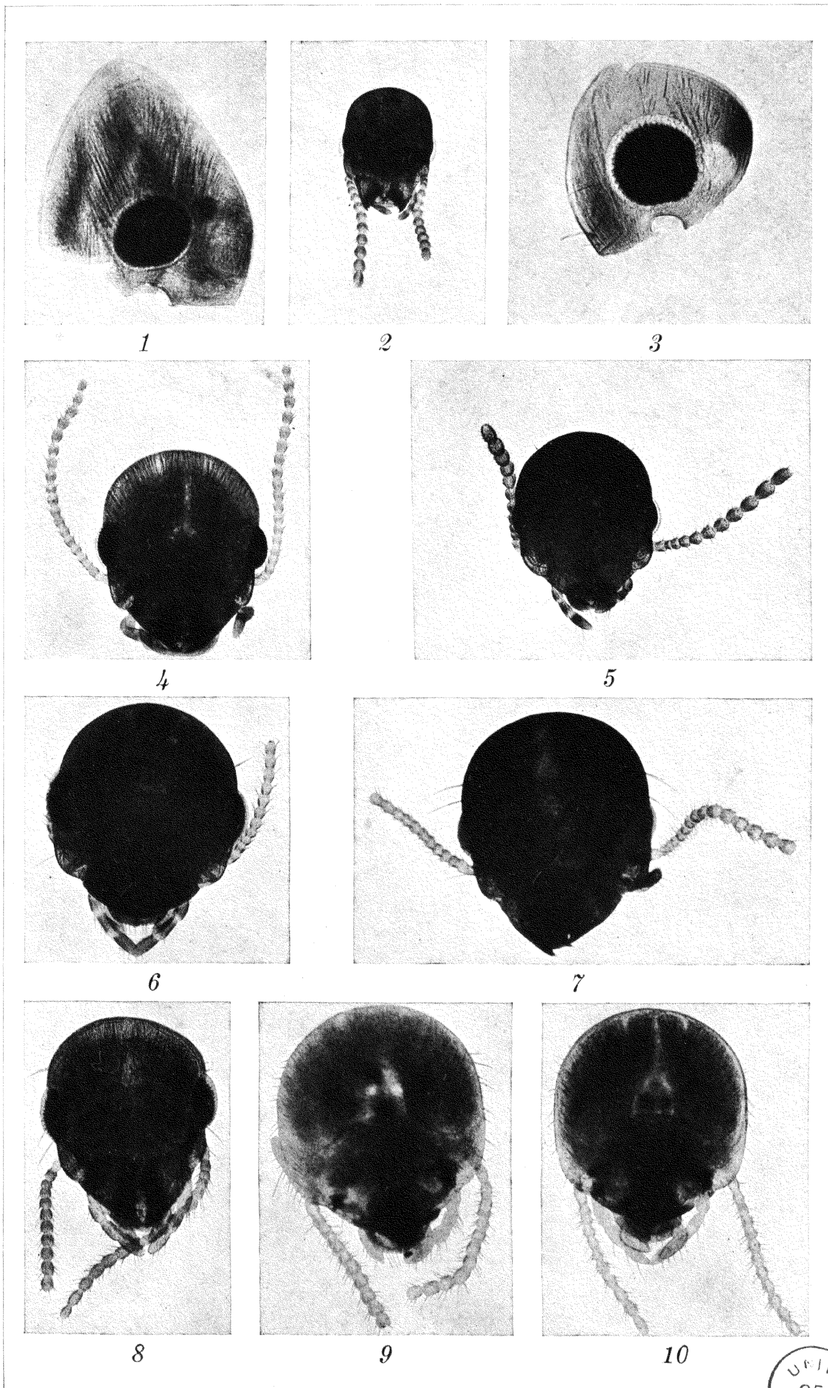


PLATE 1.



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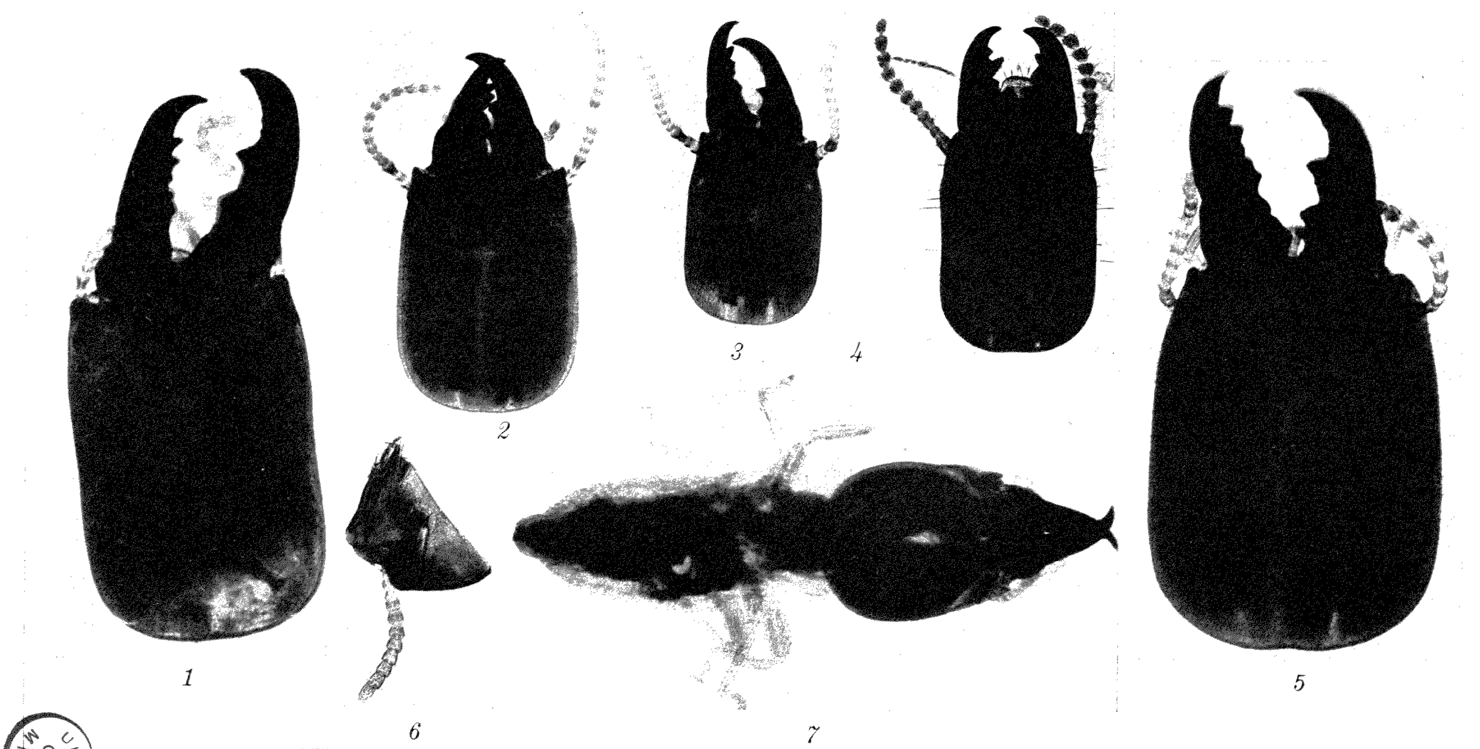
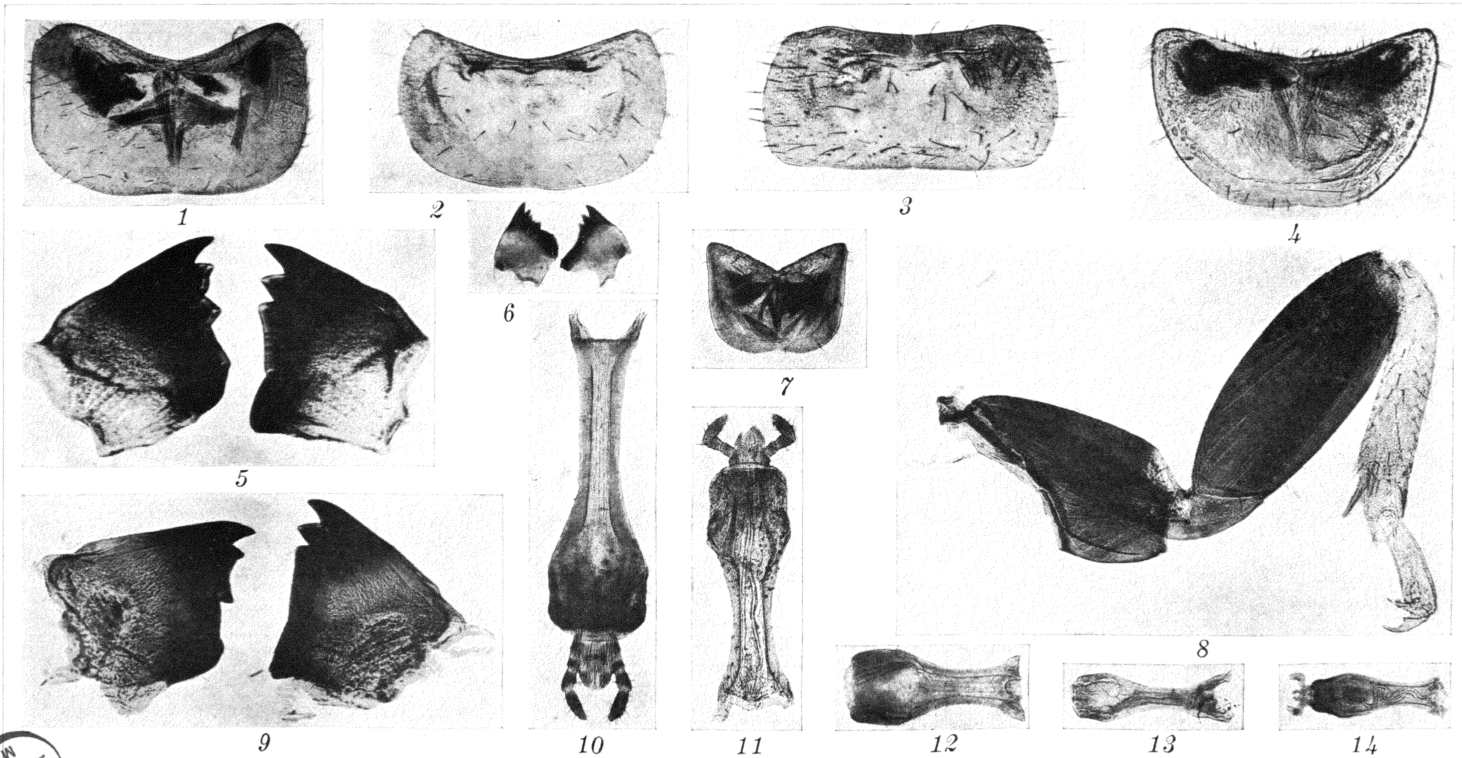


PLATE 3.

PLATE 4.



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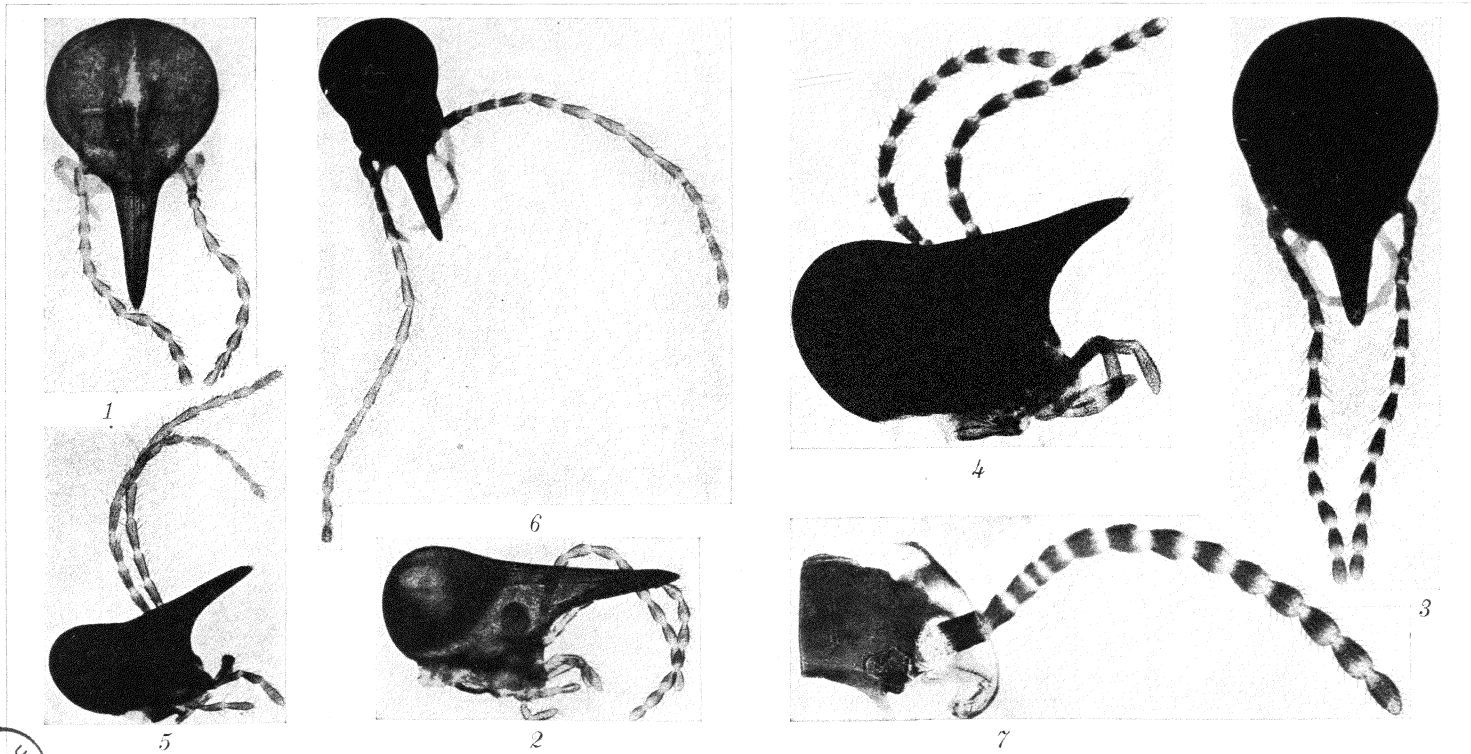

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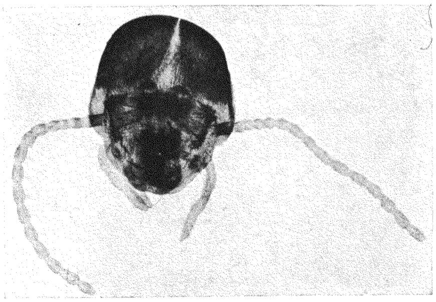

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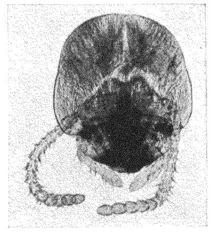

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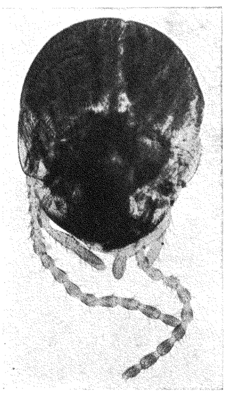

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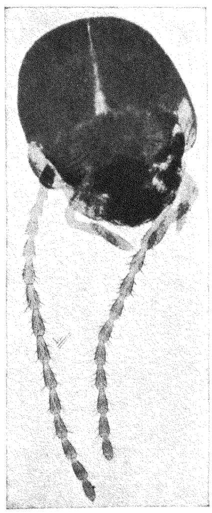

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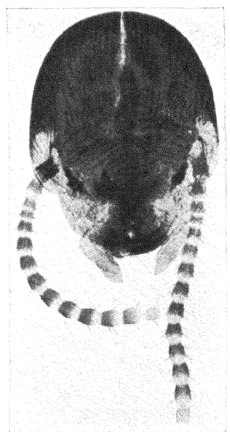

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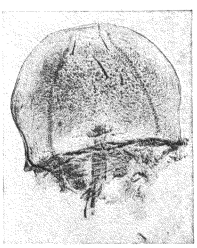

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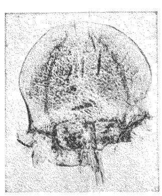

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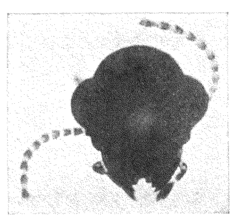

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PLATE 7.

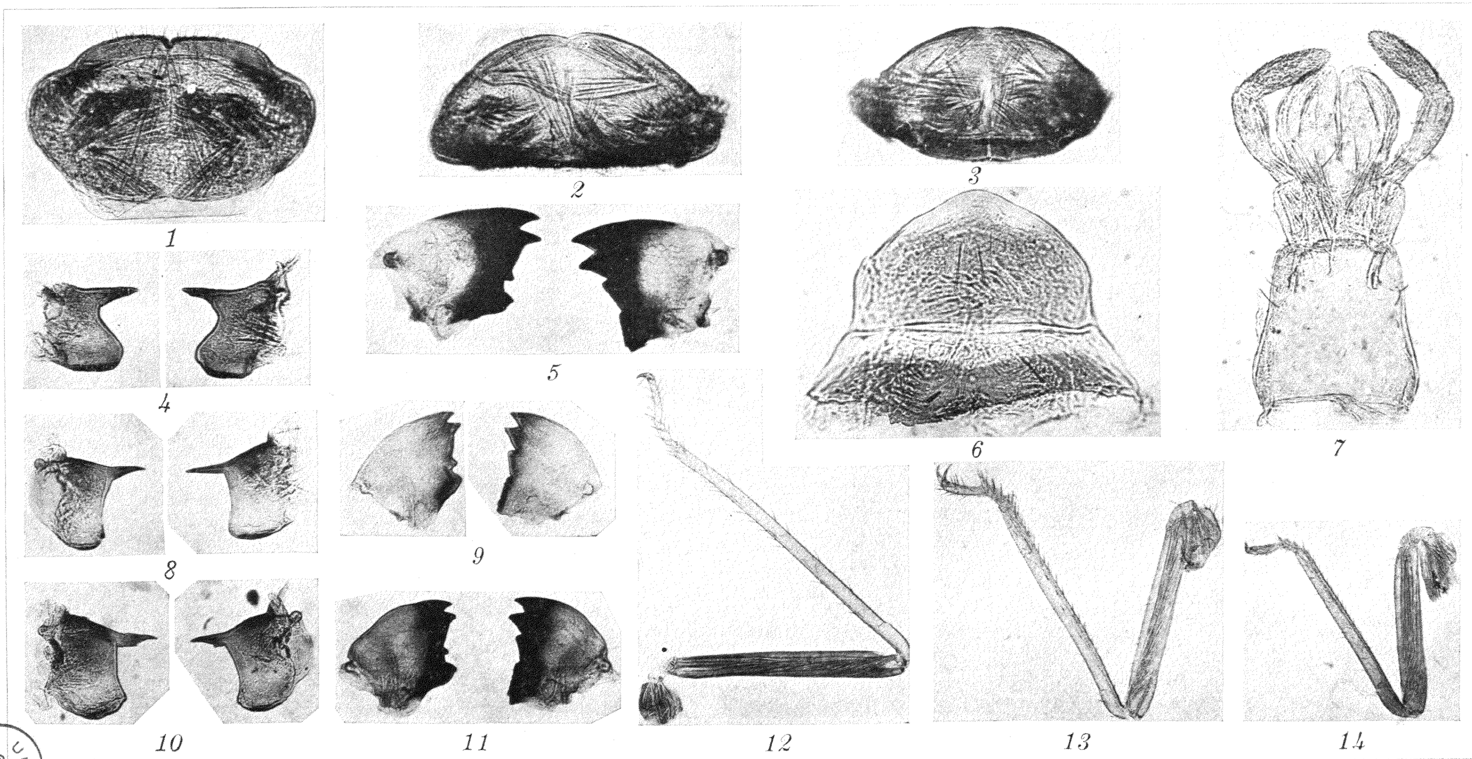

PLATE 8.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), VI[1]

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

TWO PLATES

The crane flies discussed at this time are almost entirely based on extensive collections made by Prof. Syuti Issiki on Mount Kirishima, in southern Kiushiu, Japan; in the rich native forest on the mountains of Yakushima Island, south of Kiushiu; and at Arisan and Chikurin, in the mountains of Formosa. A few additional species were taken in China, kindly submitted by Professor Jacot and Mr. H. S. Parish, and an interesting *Tipula* was sent by Doctor Uéno, taken above 8,500 feet in the Japanese Alps, the highest altitude at which crane flies have been recorded from the main island of Japan. I am very deeply indebted to all of the above, but especially to Professor Issiki, for their kind efforts in making known the rich tipulid fauna of eastern Asia and for the privilege of retaining the types in my collection.

TIPULINÆ

TIPULA UÉNOI sp. nov.

General coloration of head and mesonotum dark, pruinose; wings light brownish, variegated with subhyaline and darker brown areas; abdomen yellow, both tergites and sternites conspicuously trivittate with brown, the outer segments more uniformly darkened; male hypopygium with the median area of the tergite produced into a compressed blackened blade; eighth sternite with the caudal margin unequally trilobed, the lobes setiferous.

Male.—Length, about 13 millimeters; wing, 14.5; antenna, about 4.2. Described from an alcoholic specimen.

Frontal prolongation of head dark brown, the nasus conspicuous; maxillary palpi black, the terminal segment exceeding the remaining segments combined. Antennæ with the scapal

[1] Contribution from the Department of Entomology, Massachusetts Agricultural College.

and first flagellar segments obscure yellow, the remainder of the organ black; flagellar segments strongly incised. Head apparently dark gray in dry specimens; vertical tubercle bifid.

Mesonotal præscutum apparently gray, the margins of the broad median stripe brown; lateral stripes more broadly dark brown; scutal lobes conspicuously blackened; posterior sclerites of mesonotum dark colored in alcohol. Pleura chiefly dark brown, possibly pruinose in fresh specimens. Halteres yellow, the knobs infuscated. Legs with the coxæ dark brown, their tips paler; trochanters obscure yellow; femora brownish yellow basally, passing into dark brown; tibiæ somewhat paler, the tips dark brown; tarsi dark brown. Wings pale brownish, variegated with whitish subhyaline and darker brown; cells C and Sc more yellow; the subhyaline areas are especially broad and conspicuous before the cord, there forming an incomplete crossband; other more-restricted pale areas beyond the stigma in cells R_2 and R_3 and in the bases of the anal cells. Venation: Rs relatively long and straight; R_{1+2} entire but without macrotrichia; cell 1st M_2 very small, pentagonal; petiole of cell M_1 relatively long, approximately three times m.

Abdominal tergites yellow, trivittate with brown, the median stripe being continuous and especially conspicuous; outer segments, including the hypopygium, more infuscated; sternites more evidently trivittate with dark brown. Male hypopygium, (Plate 2, fig. 19) with the tergite, *9t*, and sternite, *9s*, extensively fused; median portion of the tergal region (Plate 2, fig. 20) produced caudad into a broad lobe, the apex blackened; viewed from above, the apex is weakly carinate; viewed laterally, the lobe is developed beneath into a compressed blade. Outer dististyle a flattened pale blade, a little dilated apically. Inner dististyle, *id*, bidentate, the outer margin at base again toothed. Eighth sternite (Plate 2, fig. 21) pale, the caudal margin broadly notched, forming wide lateral lobes that bear longer setæ; median region beneath further produced into a smaller lobule.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Mount Kiso, Komagatake, Shinano, altitude 2,700 meters, on snow, August, 1928 (*M. Uéno*).

I take great pleasure in naming this interesting *Tipula* in honor of the collector, Dr. Masuzo Uéno. *Tipula uénoi* is allied and generally similar to *T. shomio* Alexander (Japan), differing in the diagnostic features indicated, especially the coloration of the body and wings.

LIMONIINÆ

LIMONIINI

LIMONIA (LIBNOTES) RECURVINERVIS sp. nov.

General coloration greenish yellow, the præscutum with a median brownish black stripe; antennal scape black, the flagellum greenish; knobs of halteres dark brown; femora yellow, the tips rather narrowly blackened; wings hyaline, with a restricted brown pattern; vein 2d A bent at a right angle into the margin; male hypopygium with the ventral dististyle large and fleshy, the rostral prolongation short, blackened apically, the two spines unequal, divergent.

Male.—Length, about 7.5 millimeters; wing, 8.

Rostrum and palpi black. Antennæ with the scape black, the flagellar segments green, long-oval. Head dark, pruinose.

Pronotum black, paling to yellow on the sides. Mesonotal præscutum yellow with a broad brownish black median stripe that is a little constricted before midlength, thence widened to the suture; scutal lobes conspicuously brownish black, the median area broadly pale yellow; scutellum dark brown, split by a narrow median yellow vitta; postnotum chiefly darkened. Pleura, including the pleurotergite, pale yellow. Halteres of moderate length, pale yellow, the knobs dark brown. Legs with the coxæ and trochanters greenish yellow; femora yellow, the tips blackened; tibiæ obscure brownish yellow, the tips very narrowly darkened; basitarsi brownish yellow, the distal third and remainder of tarsi blackened; claws long and slender, with a single basal spine. Wings hyaline, iridescent, the prearcular and costal region more yellowish; a restricted dark brown pattern, as follows: At arculus; a narrow seam at origin of Rs; Sc_2; a circular stigma; very narrow seams on the cord and outer end of cell 1st M_2; the extreme wing tip in cells R_2 to R_5; narrow marginal seams on the medial, cubital, and anal veins, large and conspicuous on the 2d anal vein; axillary region in cell 2d A narrowly darkened; veins yellow, darker in the infuscated areas. Venation: Sc long, Sc_1 extending to some distance beyond the fork of Rs, Sc_2 just beyond this fork; Rs strongly arcuated to feebly angulated; m-cu more than one-half its length beyond the fork of M; vein 2d A bent at a right angle into the margin.

Abdominal tergites dark brown, the caudal margins of the segments very narrowly pale; sternites pale greenish yellow; hypopygium pale. Male hypopygium (Plate 2, fig. 22) with the tergite, *9t*, parallel-sided, the caudal margin with a very broad

V-shaped notch. Basistyle, *b*, small, the ventromesal lobe low and relatively inconspicuous. Ventral dististyle, *vd*, large and fleshy, much larger than the basistyle, the rostral prolongation short and stout, blackened apically and with a longitudinal blackened ridge the entire length; the two rostral spines are basal in position, the outer stouter but only a little longer than the inner, the spines divergent. Dorsal dististyle a slightly curved rod that terminates in a long acute spine. Gonapophyses, *g*, with the mesal apical lobe slender, the tip acute, the margin microscopically serrulate. Ædeagus, *a*, terminating in two divergent flaps. Anal tube with a marginal series of long powerful setæ almost to the apex.

Habitat.—Western China.

Holotype, male, Kwanhsien, Sze-chwan, June 7, 1928, through Mr. Herbert S. Parish.

I would have identified the present species as *L. trimaculata* Brunetti of the eastern Himalayas, except for the fact that neither Brunetti nor Edwards mentions the recurved 2d anal vein, nor is it figured by Bagchi. In any case, the name *Limnobia trimaculata* Brunetti (1912) is preoccupied by *Limnobia trimaculata* Zetterstedt (1838). The present species and related forms, although most conveniently placed in *Libnotes,* show certain venational features of *Limonia* and hypopygial and ungual characters that cannot be distinguished from those of numerous species of *Dicranomyia.*

LIMONIA (GERANOMYIA) RADIALIS sp. nov.

General coloration obscure yellow, the rostrum and antennæ black; head black with a median gray line; legs yellow; wings grayish yellow, with a very restricted brown pattern that is confined to the veins; Sc long, Sc_1 extending to just before the fork of Rs; male hypopygium with the ventral dististyle bearing two long divergent rostral spines that arise from enlarged bases.

Male.—Length, excluding rostrum, about 5.5 to 6.5 millimeters; wing, 6.5 to 7.5; rostrum, 2.4 to 2.6.

Rostrum and palpi black. Antennæ black throughout; flagellar segments suboval, gradually decreasing in size outwardly, with short inconspicuous verticils. Head black, with a dorsomedian silvery gray line extending the entire length of the head.

Pronotum obscure yellow, restrictedly darkened on sides. Mesonotal præscutum obscure yellow, sparsely pruinose, with a narrow brown median line; scutal lobes conspicuously and extensively dark brown, weakly pruinose; median region of scutum

and scutellum yellow, with a capillary dark line; postnotal mediotergite pruinose, darker posteriorly and laterally, each anterolateral angle wih a small yellow spot. Pleura testaceous-yellow, the dorsal pleurites more infuscated to form an ill-defined brown stripe. Halteres yellow, the knobs weakly infuscated. Legs with the coxæ and trochanters yellow; femora obscure yellow, slightly darker toward tips; tibiæ brown, the tips and the tarsi slightly paler, more yellowish brown. Wings (Plate 1, fig. 1) grayish yellow; cells Sc and Cu_1 clearer yellow; a very sparse brown pattern that is chiefly in the costal and radial fields, including spots at the supernumerary crossvein in cell Sc, origin of Rs, tip of Sc, the stigma, tip of vein R_3 and as narrow seams along the cord, outer end of cell 1st M_2 and as very vague marginal clouds at ends of the anal veins; veins pale brown, veins Cu, 1st A, and 2d A more yellowish. Venation: Sc unusually long, Sc_1 ending just before the fork of Rs, Sc_2 at its tip; a supernumerary crossvein in cell Sc; cell 1st M_2 closed; m-cu before the fork of M, the distance variable.

Abdominal tergites brownish yellow, indistinctly variegated with darker; sternites chiefly clear yellow. Male hypopygium (Plate 2, fig. 23) with the basistyle, *b*, relatively small. Ventral dististyle, *vd*, very large and fleshy, the rostral prolongation with two long divergent spines arising from enlarged basal tubercles. Gonapophyses, *g*, with the mesal-apical lobe very short. One dististyle of the holotype shows three rostral spines instead of the apparently normal number of two.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*). Paratopotype, a teneral male.

Limonia (*Geranomyia*) *radialis* is most closely allied to *L.* (*G.*) *avocetta* (Alexander), differing especially in the unusually long Sc, the more-restricted brown wing pattern, and the structure of the male hypopygium.

LIMONIA (GERANOMYIA) ALPESTRIS sp. nov.

General coloration dark gray, the humeral region of the præscutum and the scutellum more yellowish; ventral thoracic pleura pale; femora with a dark subterminal ring; wings grayish, the costal region more yellowish; a heavy dark brown pattern that is chiefly costal in position, the third and fourth areas above Rs very extensive, confluent or nearly so; abdominal tergites dark brown, the sternites obscure yellow.

Female.—Length, excluding rostrum, about 5.5 millimeters; wing, 7.2; rostrum, about 2.

Rostrum moderately elongate, black; palpi black. Antennæ black throughout; flagellar segments oval. Head dark, pruinose, the anterior vertex paler gray.

Pronotum dark brownish gray. Mesonotal præscutum dark gray, the humeral region restrictedly pale yellow, the disk with four narrow darker lines, the more lateral pair representing the interspaces; scutal lobes dark gray, the median region and the scutellum conspicuously pale yellow; postnotum dark, heavily pruinose. Pleura dark gray, the sternopleurite, meron, and pteropleurite pale yellow. Halteres yellow at base, the remainder infuscated. Legs with the coxæ and trochanters pale yellow; femora obscure yellow, brighter basally, deepening to a subterminal dark brown ring, the tips again narrowly yellow; tibiæ and tarsi pale brown, the outer segments of the latter passing into black. Wings (Plate 1, fig. 2) grayish, the prearcular and costal regions more yellowish; a heavy, chiefly costal brown pattern, including seven major areas, the third and fourth, placed above the origin of Rs and at end of Sc confluent in cell G or nearly so; those portions of the second and third areas in cell R paler, with narrow darkened margins; stigmal area largest; a vague paler cloud between the first and second areas; interrupted seams along cord and outer end of cell 1st M_2; small marginal areas at ends of veins Cu_1, 1st A, and 2d A, the last-named larger; veins pale yellow, those in the clouded areas more infuscated. Costal fringe (female) short. Venation: Sc long, Sc_1 ending about opposite midlength of Rs, Sc_2 at its tip; R_2 and free tip of Sc_2 in alignment; cell 1st M_2 long and narrow, rectangular, subequal to the longest vein beyond it; m-cu at fork of M, shorter than the distal section of Cu_1.

Abdominal tergites dark brown, the sternites obscure yellow; ovipositor with the valves relatively short, yellowish horn color, the tergal valves unusually slender and nearly straight, their bases darkened.

Habitat.—Formosa.

Holotype, female, Heigansan, altitude 5,800 feet, October 24, 1928 (*S. Issiki*).

Limonia (*Geranomyia*) *alpestris* is apparently most closely allied to *L.* (*G.*) *septemnotata* (Edwards), which is similarly a late fall species from the higher mountains of Formosa. The latter species differs in the reddish brown coloration of the thorax, uniformly brown legs, and the distribution of the wing pattern.

LIMONIA (THRYPTICOMYIA) APICALIS MAJUSCULA subsp. nov.

Male.—Length, about 7 to 7.5 millimeters; wing, 6.5 to 7.3.

Female.—Length, about 7 millimeters; wing, 7 to 7.2.

Generally similar to typical *Limonia* (*Thrypticomyia*) *apicalis* (Wiedemann), differing especially in the larger size, which approximates that of *L.* (*T.*) *brevicuspis* Alexander. Legs with the proximal fifth (forelegs) to third (hind legs) of the basitarsi blackened. Wings nearly hyaline, with iridescent reflections, the wing tip broadly and distinctly infumed; stigma elongate-oval, dark brown; veins black. Venation: Sc_1 long; R_1 relatively long, more than two and one-half times R_2 alone; m-cu at near two-thirds to three-fourths the length of cell 1st M_2. Male hypopygium with the rostral prolongation of the ventral dististyle unusually long and slender, as in *apicalis;* spines nearly equal in size and slightly separated, the more proximal arising from a basal tubercle.

Habitat.—Formosa.

Holotype, male, Tozan, near Rato, November 5, 1928 (*S. Issiki*). Allotopotype, female. Paratopotypes, three males.

HELIUS (HELIUS) CHIKURINENSIS sp. nov.

General coloration dark brown; rostrum approximately as long as the remainder of the head; wings with a brownish tinge; male hypopygium with the outer dististyle produced into a curved apical point, with a small subapical tooth; gonapophyses appearing as pale flattened blades that are produced laterad into long acute points.

Male.—Length, about 4.8 millimeters; wing, 5.

Rostrum approximately as long as the remainder of head, black; palpi black. Antennæ black, the outer segments paling to brown; basal flagellar segments short and crowded, the outer segments more elongate, with long conspicuous verticils. Head dark brownish gray.

Thorax dark brown, the anterior lateral pretergites and adjoining regions more yellowish. Pleura dark brown, the dorsal pleurotergite paler. Halteres dusky, the base of the stem narrowly yellow. Legs with the coxæ and trochanters yellowish testaceous; remainder of legs brownish yellow, especially the tarsi. Wings (Plate 1, fig. 3) with a brownish tinge, the stigmal region darker but ill-delimited; veins darker brown. Costal fringe (male) relatively long. Venation: Sc_1 ending shortly before the fork of Rs, Sc_2 near its tip; veins R_3 and R_{4+5} strongly

diverging; inner end of cell 1st M_2 more or less pointed; m-cu opposite r-m or nearly so.

Abdomen brownish black, the sternites paler. Male hypopygium (Plate 2, fig. 24) with the outer dististyle, *od*, a slender blackened rod, narrowed to the curved acute apex, before the tip with a smaller denticle. Gonapophyses, *g*, appearing as flattened plates that are produced laterad into long apical spines. Ædeagus, *a*, relatively short, straight, parallel-sided.

Habitat.—Formosa.

Holotype, male, Chikurin, altitude 3,000 feet, July 31, 1928 (*S. Issiki*). Paratopotype, one male.

HELIUS (HELIUS) CHIKURINENSIS MINUSCULUS subsp. nov.

Male.—Length, about 4 millimeters; wing, 4.

Generally similar to typical *chikurinensis*, differing especially in the structure of the male hypopygium, where the gonapophyses (Plate 2, fig. 25) are of quite different appearance, the apical point being bent across the blade.

Habitat.—Formosa.

Holotype, male, Chikurin, altitude 3,000 feet, July 31, 1928 (*S. Issiki*).

PEDICIINI

TRICYPHONA BAIKALICA sp. nov.

Large (wing, male, 15 millimeters); general coloration gray, the præscutum with three darker gray stripes; wings grayish, with a heavy brown pattern distributed chiefly along the costal border and along the cord; cell 1st M_2 present.

Male.—Length, about 17 millimeters; wing, 15.

Rostrum and palpi black. Antennæ black, the basal segment more pruinose; antennal segments apparently not exceeding fourteen; flagellar segments short and crowded, the basal nine segments broader than long, the remainder small and poorly differentiated, provided with long conspicuous verticils. Head dark, pruinose; vertical tubercle conspicuous.

Mesonotal præscutum light gray, with three darker gray stripes; remainder of mesonotum dark gray, more or less discolored in the type. Pleura dark gray, pruinose; dorsopleural region dark. Halteres yellow. Legs with the coxæ dark, pruinose; trochanters dark, the posterior trochanters paler; femora brownish yellow, the tips broadly blackened; tibiæ dark brown, the tips blackened; tarsi black. Wings (Plate 1, fig. 4) grayish with a heavy brown pattern that is chiefly costal, with a very broad, irregular seam along the cord; the darkened areas include the prearcular region; cells C and Sc; about the basal third of

cells R and M; a large area at origin of Rs, including most of cell R_1; most of outer radial cells; seam along cord unusually wide, including all of cell 1st M_2; anal cells less distinctly suffused with brown; veins brown. Venation: Sc_2 just basad of the origin of Rs, the latter strongly angulated and spurred; r-m just before the fork of Rs; R_2 transverse; R_{4+5} shorter than the gently sinuous r-m; cell 1st M_2 closed; m-cu before the fork of M.

Abdomen dark, heavily pruinose; extreme margins of the segments paler; hypopygium black. Male hypopygium (Plate 2, fig. 26) with the interbasal hook of the basistyle, *b*, a flattened cultriform blade. Dististyle, *d*, large and complex in form, roughly bilobed.

Habitat.—Siberia.

Holotype, male, Turan, Baikal, through Staudinger and Bang-Haas.

Tricyphona baikalica is very distinct from all described regional species.

TRICYPHONA YAKUSHIMANA sp. nov.

Size small (wing, male, not exceeding 6 millimeters); general coloration brown; wings grayish yellow, clouded with pale brown; R_2 oblique, sinuous, longer than R_{1+2}; R_4 captured by R_{2+3}, R_{2+3+4} being nearly one-third R_{2+3}; cell 1st M_2 closed.

Male.—Length, about 4.2 to 4.5 millimeters; wing, 5.6 to 6.

Rostrum and palpi brown. Antennæ 16-segmented, the basal segments dark brown, the outer half of the flagellum paling to brownish yellow; antennæ of moderate length, if bent backward extending approximately to the wing root; basal flagellar segments short and crowded, the outer segments elongate, with more-conspicuous verticils. Head dark grayish brown.

Thorax high and gibbous. Mesonotum brown, very vaguely pruinose, without stripes. Pleura more brownish yellow, especially the anepisternum and sternopleurite in cases. Halteres obscure yellow to dusky, the base of the stem restrictedly pale. Legs with the coxæ and trochanters brown; remainder of legs light brown, the tarsal segments somewhat darker. Wings (Plate 1, fig. 5) with a grayish yellow ground color, vaguely clouded with pale brown, the stigmal region darker brown; the dusky clouds include all crossveins and deflections of veins. Venation: Sc_2 nearly midway between arculus and origin of Rs; R_2 oblique, sinuous, longer than R_{1+} ; R_{2+3+4} nearly one-third R_{2+3}; cell M_1 subequal to its petiole; cell 1st M_2 closed; m-cu about its own length beyond the fork of M; anal veins elongate.

Abdominal tergites dark brown, including the hypopygium; basal sternites paler, especially on the basal rings. Male hypopygium (Plate 2, fig. 27) with caudal margin of tergite, *9t*, transverse, the lateral angles produced into very large conspicuous hooks that terminate in a long straight spine. Basistyle, *b*, bearing a fingerlike glabrous lobe on face at near two-thirds the length; apex of style terminating in two low spinous lobes, the small, ribbonlike dististyle, *d*, arising between these lobes.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*). Paratopotype, male.

Tricyphona yakushimana is a very distinct species with no known close allies. The venation of the radial field, especially the position and course of vein R_2, is intermediate between that of *T. formosana* Alexander and of the normal pediciine type, where R_2 is straight and has assumed a transverse or slightly oblique position.

HEXATOMINI

ULA FLAVIDIBASIS sp. nov.

General coloration of thorax dark gray, the mesonotal præscutum with three dark brown stripes; coxæ blackened, pruinose; wings brownish yellow, the base and costal region light yellow; a restricted dark pattern, chiefly along the cord; basal abdominal sternites light yellow.

Female.—Length, about 7 millimeters; wing, 8.4.

Rostrum and palpi black. Antennæ black throughout, relatively elongate, the flagellar segments fusiform, with verticils that only slightly exceed the segments in length. Head dark gray, the anterior vertex and narrow posterior orbits clearer gray.

Pronotum gray. Mesonotal præscutum gray with three dark brown stripes that are dusted with a sparse yellow pollen; remainder of mesonotum chiefly dark gray. Pleura black, heavily gray pruinose, the dorsopleural membrane dusky. Halteres yellow, the knobs infuscated. Legs with the coxæ blackened, pruinose, the extreme tips and inner faces pale; trochanters infuscated; femora black, the bases narrowly yellow, the amount on the forelegs including about the basal fifth; tibiæ and tarsi dark brown. Wings (Plate 1, fig. 6) brownish yellow, the base and costal region light yellow; a restricted brown pattern includes both ends of the light yellow stigma, the cord, origin of Rs, and outer end of cell 1st M_2; veins brown, more yellowish in the flavous areas. Venation: Rs angulated at origin; basal section of R_5 reduced.

Abdominal tergites dark brown, blackened laterally, the terminal segments uniformly darkened; basal sternites uniformly light yellow; ovipositor with the valves dark horn-brown.

Habitat.—Formosa.

Holotype, female, Arisan, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*).

Ula flavidibasis is most closely allied to *U. perelegans* Alexander (northern Japan), differing especially in the coloration of the thorax, legs, and wings. The almost uniformly blackened, heavily pruinose coxæ of the present species are very conspicuous.

ADELPHOMYIA ARIANA sp. nov.

General coloration black; antennal flagellum pale; wings with a strong brown suffusion; male hypopygium with the apex of the basistyle produced into a slender point.

Male.—Length, about 4 millimeters; wing, 5.2.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi brownish black. Antennæ relatively long and slender for a member of the genus, if bent backward extending to slightly beyond the wing root; basal segments brownish black, the flagellum passing into pale yellow. Head black.

Thorax black, including the dorsopleural region. Halteres dusky, the base of the stem narrowly whitened. Legs with the coxæ dark; trochanters obscure whitish; remainder of legs pale brown. Wings (Plate 1, fig. 7) with a strong brown suffusion, the stigmal region slightly darker; veins dark brown. Macrotrichia of cells relatively abundant, occupying the outer ends of cells R_2 to 1st A inclusive. Venation: Sc_1 relatively long, exceeding m-cu; Rs strongly angulated at origin; R_{2+} two to three times R_2 alone; cell M_1 present; m-cu at near midlength of cell 1st M_2.

Abdomen black, including the genitalia of both sexes. Male hypopygium (Plate 2, fig. 28) with the apex of the basistyle, *b*, produced into a slender point that is microscopically roughened. Outer dististyle, *od*, slender, dilated at apex, provided with three slender denticles.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*). Allotopotype, female, altitude 7,300 feet.

Adelphomyia ariana is readily separated from *A. nipponensis* Alexander (Japan: Honshiu) by the black body coloration and darkened wings. The genus *Adelphomyia* is new to the fauna of Formosa.

PSEUDOLIMNOPHILA CHIKURINA sp. nov.

General coloration brownish gray; antennæ black throughout; wings with a grayish tinge, the stigma vaguely darker; R_{2+3+4} relatively short, about one-fourth longer than R_{1+2}; m-cu shortly beyond the fork of M and before the level of r-m; male hypopygium with the outer dististyle very slender and entirely blackened.

Male.—Length, about 4.5 millimeters; wing, 5.6.

Rostrum and palpi brown. Antennæ (male) black throughout, of moderate length, if bent backward extending about to the root of the halteres; flagellar segments cylindrical, gradually shortened outwardly, with long conspicuous verticils that much exceed the segments. Head brownish gray, the relatively broad anterior vertex clearer gray.

Pronotum brownish gray. Mesonotal præscutum brownish gray, the median stripe darker brown, the lateral stripes less distinct; pseudosutural foveæ black; tuberculate pits distinct; posterior sclerites of mesonotum grayish brown. Pleura brownish gray. Halteres obscure testaceous, the knobs dusky, the base of the stem brighter. Legs with the coxæ pale, slightly pruinose, especially the fore coxæ; trochanters testaceous, remainder of legs broken. Wings (Plate 1, fig. 8) with a grayish tinge, the stigma only vaguely darker; veins pale brown. Costal fringe short. Venation: Sc_1 ending shortly before the fork of Rs, Sc_2 near its tip; R_{2+3+4} relatively short, only about one-fourth longer than R_{1+2}; R_{2+3} subequal to R_2; cell M_1 present, longer than its petiole; m-cu shortly beyond the fork of M, before the level of r-m; anterior arculus present.

Abdominal tergites dark brown, the sternites paler. Male hypopygium with the outer dististyle very slender and entirely blackened, gradually narrowed to the simple acute apex. Inner dististyle a little shorter, entirely pale, with abundant coarse setæ. Gonapophyses bispinous.

Habitat.—Formosa.

Holotype, male, Chikurin, altitude 3,000 feet, July 31, 1928 (*S. Issiki*).

Pseudolimnophila chikurina is allied to *P. inconcussa* (Alexander), differing especially in the venation and the structure of the outer dististyle of the male hypopygium.

Genus NIPPOLIMNOPHILA novum

Characters generally as in *Limnophila* Macquart, differing as follows: Antennæ 11-segmented (Plate 2, fig. 29), both scapal segments elongate and approximately equal in size; flagellar seg-

ments with relatively short verticils, not or only slightly longer than the segments themselves. Anterior vertex wide; head short and broad, not narrowed behind. No tuberculate pits. Halteres very elongate, exceeding the length of the thorax. Tibial spurs present. Wings (Plate 1, figs. 9, 10) with Sc relatively short, Sc_1 ending before the fork of Rs, Sc_2 near its tip; cell M_1 lacking; anterior arculus preserved; anal angle lacking. Veins pale, the macrotrichia much reduced in size and number. Male hypopygium (Plate 2, fig. 30) with both dististyles simple; tergal region evenly convex; eighth sternite produced ventrad, the ædeagus, *a*, strongly decurved, the tip recurved and directed toward the notch of the eighth sternite.

Genotype, *Nippolimnophila kiusiuensis* sp. nov. (Palæarctic Region).

Nippolimnophila yakushimensis sp. nov. likewise belongs here. The chief generic characters lie in the structure of the antennæ which are here reduced to an 11-segmented organ, with the second scapal segment (pedicel) of an unusual length. The only other crane flies with an elongate pedicel are found in the eriopterine genus *Chionea* Dalman and allied forms. The fact that the entire series of specimens of the two species referred to this genus, totaling more than a score of individuals, included only males may indicate that the female is subapterous.

NIPPOLIMNOPHILA KIUSIUENSIS sp. nov.

General coloration brownish gray; antennæ short; cell 2d A relatively long and narrow.

Male.—Length, about 3.5 to 4.5 millimeters; wing, 4.5 to 6.

Rostrum and palpi black. Antennæ black throughout, short (Plate 2, fig. 29), if bent backward not extending far beyond the pronotum; flagellar segments oval, with short verticils that slightly exceed the segments in length. Head brownish gray, the orbits clearer gray.

Mesonotum brownish gray, the præscutal stripes lacking or ill-defined. Pleura brownish gray. Halteres pale, the knobs dusky. Legs with the coxæ and trochanters brown, pruinose; remainder of legs dark brown, the femoral bases very restrictedly pale. Wings (Plate 1, fig. 9) milky white, the stigma and vague seams at origin of Rs, along cord and outer end of cell 1st M_2 pale brown; veins brown. Venation: R_{2+3+4} nearly twice the basal section of R_5; veins issuing from cell 1st M_2 somewhat divergent; m-cu at near midlength of cell 1st M_2; vein 2d A relatively elongate, the cell narrow.

Abdomen, including the hypopygium, dark brown. Male hypopygium (Plate 2, fig. 30) with the outer dististyle *od*, bearing a series of conspicuous setæ along the outer face, the darkened apex simple, glabrous. Inner dististyle a shorter rod, heavily blackened, terminating in a slightly dilated head.

Habitat.—Japan (Kiushiu).

Holotype, male, Mount Kirishima, altitude 2,500 feet, May 3, 1929 (*S. Issiki*). Paratopotypes, 1 male; 5 additional males at 3,000 to 3,500 feet, May 4, 1929 (*S. Issiki*).

NIPPOLIMNOPHILA YAKUSHIMENSIS sp. nov.

Male.—Length, about 4 to 4.4 millimeters; wing, 4.5 to 5.3.

Generally similar to *N. kiusiuensis* sp. nov., differing especially in the elongate antennæ of the male which are here approximately as long as the thorax, if bent backward extending about to the root of the halteres; flagellar segments fusiform. Wings (Plate 1, fig. 10) with cell 2d A somewhat shorter.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*). Paratopotypes, 20 males.

ULOMORPHA POLYTRICHA sp. nov.

General coloration polished black; halteres yellow; wings tinged with brownish, scarcely variegated with darker; macrotrichia of membrane very numerous; cell M_1 lacking.

Male.—Length, about 7.5 millimeters; wing, 7.6.

Rostrum shiny black, the mouth parts paler; palpi brownish black. Antennæ relatively long and slender, the scape black, the flagellum pale brown; flagellar segments elongate-cylindrical, with verticils that exceed the segments. Head shiny black.

Pronotum and mesonotum shiny polished black. Pleura black, the sternopleurite paling to brown. Halteres pale, the knobs light yellow. Legs with the coxæ obscure yellow, the fore coxæ more darkened basally; trochanters yellow; femora obscure yellow, the tips narrowly infuscated, more broadly so on the fore femora; tibiæ and tarsi brown; legs conspicuously hairy. Wings (Plate 1, fig. 11) tinged with brownish, the base and costal region clear yellow; a scarcely indicated darker clouding along the cord; stigma small, darker than the ground color; veins brown, light yellow in the luteous areas. Conspicuous macrotrichia in almost all cells of wing, lacking only in the extreme bases of the chief basal cells and in the prearcular and subcostal cells. Venation: Rs angulated but scarcely spurred

at origin; R_{2+3+4} shorter than the basal section of R_5, the veins beyond it longer and less divergent than in *nigricolor;* cell M_1 lacking; m-cu at near midlength of cell 1st M_2.

Abdomen reddish brown, trivittate with black; hypopygium black.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*).

Ulomorpha polytricha is readily distinguished from *U. nigricolor* Alexander (Japan: Honshiu) by the nearly immaculate wings with more-abundant macrotrichia. In both wings of the unique type there is a short marginal spur in cell 2d M_2 that presumably represents the partly atrophied vein M_2.

ERIOCERA PLATYSOMA sp. nov.

Abdomen of male dilated and flattened; general coloration velvety black, the basal four segments of abdomen orange; wings, legs, and halteres black.

Male.—Length, about 16 millimeters; wing, 14, width of abdomen, 4.5.

Rostrum, palpi, and antennæ black, the last 7-segmented, the flagellar segments decreasing in size outwardly, the terminal segment abruptly smaller, about one-fifth the penultimate. Head velvety black.

Thorax deep velvety black, the scutellum dull orange. Halteres and legs entirely black. Wings blackish, the outer half of the wing more suffused, the medial, cubital, and anal cells more streaked with dusky; veins dark brown. Venation: Rs long, weakly angulated at origin; Sc_1 elongate, exceeding R_{2+3+4}; R_{2+3} subequal to R_{2+3+4}; cell M_1 lacking.

Abdomen broadly dilated and flattened, as shown by the measurements; segments one to four dull orange, the caudal margins of segments two to four narrowly and evenly blackened, the lateral flanges of the segments slightly infuscated; remainder of abdomen deep velvety black, the hypopygium brown.

Habitat.—Western China.

Holotype, male, Kwanhsien, Sze-chwan, October 7, 1928, through Mr. Herbert S. Parish.

Eriocera platysoma is allied to *E. abdominalis* Alexander, likewise from western China, in the great lateral development of the abdomen of the male (though presumably not of the female). It is readily told by the blackened wings and entirely black legs.

ELEPHANTOMYIA (ELEPHANTOMYIA) SEROTINA sp. nov.

Rostrum nearly as long as the remainder of the body; mesonotal præscutum obscure yellow, with a broad median dark brown stripe that widens behind; a dark transverse girdle on the pleura; halteres dusky; femora extensively blackened, especially the fore femora; wings grayish yellow, the stigma long-oval, dark brown; abdominal tergites obscure brownish yellow, darker medially, the caudal margins of the segments narrowly but completely bordered by dark brown.

Female.—Length, excluding rostrum, about 8 millimeters; wing, 9.8; rostrum, about 7.

Rostrum elongate, only a little shorter than the remainder of the body, black throughout. Antennæ yellowish brown. Head buffy brown; anterior vertex narrow.

Mesonotal præscutum obscure yellow, with a broad median dark brown stripe that widens behind; scutal lobes extensively dark brown; median region of scutum and the scutellum more testaceous-brown; postnotal mediotergite brownish black. Pleura yellow, the sternopleurite and anepisternum dark brown to produce a more or less distinct girdle. Halteres dusky, the extreme base of the stem yellow. Legs with the coxæ yellow, the outer face of the middle coxæ darker; trochanters yellow; femora chiefly brownish black, the bases more yellowish, narrowest on the forelegs where about the basal fourth is included, broadest on the posterior legs where only the tips are blackened; tibiæ dark brown, the tarsi paling to obscure brownish yellow. Wings with the ground color grayish yellow, the prearcular and costal regions more yellowish; stigma long-oval, dark brown; distinct paler brown seams along the cord and outer end of cell 1st M_2; wing apex narrowly seamed with brown; veins dark brown. Venation: Cell 1st M_2 large, subrectangular; m-cu more than one-half its length beyond the fork of M, longer than the distal section of Cu_1; cell 2d A relatively narrow.

Abdominal tergites obscure brownish yellow, the median region darker, including the dark brown caudal margins of the segments; sternites yellowish, the caudal margins of the segments narrowly dark brown; ovipositor yellowish horn color, the tips of the slender upturned tergal valves narrowly darkened.

Habitat.—Formosa.

Holotype, female, Yūsho, altitude 6,000 feet, October 24, 1928 (*S. Issiki*). Paratype, teneral female, Shōrei, altitude 7,000 to 8,000 feet, October 25, 1928 (*S. Issiki*).

Elephantomyia serotina is allied to *E. hokkaidensis* Alexander (northern Japan), differing especially in the coloration of the body and legs.

ERIOPTERINI

CERATOCHEILUS TINCTIPENNIS sp. nov.

General coloration black, pruinose, the præscutal shield darkened; rostrum, antennæ, and legs black; knobs of halteres infuscated; wings strongly tinged with brown.

Female.—Length, excluding rostrum, about 7.5 millimeters; wing, 6.5; rostrum, about 4.5.

Rostrum black. Antennæ black throughout. Head light gray, the posterior vertex darker gray; anterior vertex nearly twice as wide as the diameter of the fusion segment of the antenna.

Mesonotum blackened, the humeral region of the præscutum somewhat more pruinose; median region of the scutum and the scutellum a trifle more pruinose. Pleura black, pruinose. Halteres dusky, the knobs infuscated. Legs with the coxæ obscure brownish yellow, the outer face more infuscated; trochanters obscure yellow; remainder of legs black. Wings (Plate 1, fig. 12) with a strong brown suffusion, the veins dark brown. Macrotrichia of veins relatively numerous, there being a series of about four or five on each of Rs and the basal section of R_5; none on anterior branch of Rs. Venation: Anterior branch of Rs relatively long and sinuous; m-cu before the fork of M.

Abdomen black, pruinose. Ovipositor brownish horn color.

Habitat.—Formosa.

Holotype, female, Arisan, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*).

Ceratocheilus tinctipennis is readily distinguished from the known regional species by the coloration of the body and the strongly tinted wings.

LIPSOTHRIX YAKUSHIMÆ sp. nov.

General coloration dark brown; halteres dusky, the knobs dark brown; legs brown, the tarsi extensively whitened; wings with a strong dusky suffusion; Rs and R_{2+3+4} nearly equal in length, pale, with few or no macrotrichia.

Female.—Length, about 8.5 millimeters; wing, 8.2.

Mouth parts much reduced. Antennæ black throughout; flagellar segments oval, with long verticils; terminal segment reduced. Front yellowish testaceous, the posterior portion of the head darker, the disk of the vertex dark brown.

Thorax dark brown, the median region of the scutum more yellowish; dorsopleural region pale. Halteres dusky, the knobs

dark brown. Legs with the coxæ and trochanters brownish testaceous; femora and tibiæ brown, the genua and narrow tips of the tibiæ paler; tarsi with the outer segments conspicuously whitened. Wings (Plate 1, fig. 13) with a strong dusky suffusion; a conspicuous whitish streak in cell M, crossing m-cu into the base of cell M_4; veins brown. Veins Rs and R_{2+3+4} pale and without macrotrichia or nearly so. Venation: Rs only a trifle longer than R_{2+3+4}; inner end of cell 1st M_2 slightly arcuated; m-cu a short distance beyond the fork of M.

Abdomen brownish black, the genital segment obscure brownish yellow. Ovipositor with the valves blackened.

Habitat.—Japan (Kiushiu).

Holotype, female, Kosugidani, Yakushima, altitude, 2,500 feet, April 29, 1929 (*S. Issiki*).

Lipsothrix yakushimæ is most closely related to *L. taiwanica* Alexander (southern Formosa), differing in the large size and details of coloration and venation. The glabrous veins Rs and R_{2+3+4} are conspicuous features.

GONOMYIA (PTILOSTENA) CURTICELLULA sp. nov.

General coloration of body dark gray; rostrum and antennal scape dark brown; thoracic pleura abruptly pale yellow; wings with a grayish tinge, the stigma pale; cell R_3 very small; male hypopygium with the ædeagus pale, not markedly chitinized; four dististyles or branches of the same.

Male.—Length, about 4 to 4.5 millimeters; wing, 4.8 to 5.5.

Rostrum and palpi dark brown. Antennæ with the scape brownish black, the flagellum paler brown; flagellar segments elongate-fusiform, with a dense erect pubescence. Head dark gray.

Pronotum and mesonotum dark gray, the præscutum with the interspaces even darker brownish gray; pseudosutural foveæ conspicuous; centers of the scutal lobes darkened. Pleura abruptly pale yellow, the dorsal sclerites more dusky. Halteres dusky. Legs with the coxæ and trochanters pale yellow; femora yellow, the tips narrowly dark brown; tibiæ obscure yellow, the tips infuscated; tarsi passing into dark brown. Wings (Plate 1, fig. 14) relatively narrow, with a grayish tinge, the entire costal margin to the apex light yellow; stigma very pale, only a little darker than the ground color; no distinct dark clouds on membrane, but the origin of Rs, cord, and m-cu darker in color than the remaining veins; veins pale brown, the costal veins yellowish. Venation: Sc_1 ending shortly beyond origin of Rs, Sc_2 far from its tip, just before midway between arculus

and origin of Rs; R_3 nearly perpendicular; cell R_3 very small; m-cu more than its own length before the fork of M; Cu_2 extending to opposite or beyond m-cu.

Abdominal tergites brownish gray, the sternites obscure yellow; hypopygium yellow. Male hypopygium (Plate 2, fig. 31) with four arms to the dististyles, *d*, of which three are quite glabrous; outermost a slender rod, its apex darkened; longest style with the margin darkened, the apex obtuse; third branch bifid, one arm shorter and obtusely rounded. The fourth style or branch is slender, terminating in a curved apical spine, the surface of the style with about eight setæ. Ædeagus, *a*, long and slender, entirely pale.

Habitat.—Formosa.

Holotype, male, Giran, November 2, 1928 (*S. Issiki*). Paratype, male, Taihoku, May 8, 1929 (*S. Issiki*).

Gonomyia curticellula differs rather conspicuously from *G. pruinosa* Alexander (Formosa) in the nearly immaculate wings (Plate 1, fig. 15) and unusually small cell R_3. The paratype has the wings narrower, with correlated differences in venation, as a shorter Rs and cell 2d M_2 and with m-cu a greater distance before the fork of M. Despite these differences, I cannot separate the material from the type.

GONOMYIA (PTILOSTENA) SHANTUNGENSIS sp. nov.

General coloration of notum brown, pruinose; basal segments of antennæ pale, the outer segments black; pleura yellow, the dorsal region darker; wings pale brownish yellow, the stigma a little darker; Rs angulated at origin; abdominal tergites dark brown, the caudal margin of the segments narrowly ringed with yellow; sternites yellow; male hypopygium with the ædeagus entirely pale, straight, at apex curved into a gentle crook.

Male.—Length, about 4.5 millimeters; wing, 5.4 to 5.5.

Rostrum and palpi black. Antennæ with the scape obscure yellow; basal segments of flagellum likewise pale, the outer segments passing into brown. Head dark gray.

Pronotum dark brown, sparsely pruinose. Mesonotal præscutum with the ground color reddish, the humeral and lateral regions more yellowish, with a broad conspicuous dark brown stripe, the surface of the sclerite a little pruinose; pseudosutural foveæ large, reddish brown; scutum brown, the centers of the lobes vaguely darker; scutellum and postnotum dark, sparsely pruinose. Pleura pale yellow, the dorsal region infuscated. Halteres dusky. Legs with the coxæ and trochanters pale yellow, the fore coxæ a little darker; femora and tibiæ yellow, the

tips of the latter narrowly darkened; basitarsi obscure yellow, the tips narrowly darkened; terminal tarsal segments broken. Wings very pale brownish yellow, the base, costal region, and outer ends of the radial cells clearer yellow; stigma small, brown, only a little darker than the ground color; veins brown, the cord and basal portion of Rs darker. Venation: Sc_1 ending shortly beyond the origin of Rs, Sc_2 far from its tip; Rs angulated at origin; petiole of cell R_3 angulated before midlength; R_3 about one-third its length from R_{1+2} at margin; m-cu more than its length before the fork of M.

Abdominal tergites dark brown, the segments narrowly and indistinctly ringed caudally with pale yellow; sternites pale yellow. Male hypopygium (Plate 2, fig. 32) with the basistyle, *b*, lobed at apex, including a broad obtuse ventral lobe and a small mesal lobule. Three dististyles, *d*, the longest U-shaped, both arms acute and glabrous, the shorter inner arm more blackened at apex; second dististyle broadest, the apex bifid, both arms blackened, the outer longer and slenderer, the inner obtuse; third dististyle a short simple pale rod that is narrowed at apex into a blackened spine. Ædeagus, *a*, entirely pale, appearing as a straight rod, the apex curved at more than a right angle.

Habitat.—Eastern China.

Holotype, male, Lau Stan, east of Tsingtao, Shantung, June 17, 1927, taken in evening (*A. P. Jacot*).

Gonomyia shantungensis is closest to the Japanese *G. subpruinosa* Alexander and *G. pallens* Alexander, differing from all regional species in the structure of the male hypopygium.

ERIOPTERA (ERIOPTERA) ENSIFERA sp. nov.

General coloration yellow; thoracic pleura with a bluish sheen; knobs of halteres infuscated; legs yellow with only the terminal tarsal segments darkened; wings brownish yellow, with a restricted darkening along the cord; macrotrichia of veins long and conspicuous; male hypopygium with the gonapophyses long and ensiform, entirely pale in color.

Male.—Length, about 2.8 millimeters; wing, 3.8.

Female.—Length, about 3.5 to 4.5 millimeters; wing, 3.8 to 4.5.

Rostrum brownish yellow; palpi black. Antennæ pale brown. Head cinnamon brown.

Mesonotal præscutum light cinnamon brown, with scarcely indicated markings, the humeral region more yellowish; scutellum and postnotum more yellowish, with a narrow brown median line in the male, this not indicated in the female. Pleura pale,

with a distinct bluish sheen, most evident when viewed from above and behind. Halteres pale, the knobs infuscated. Legs yellow, the terminal two segments dark brown. Wings (Plate 1, fig. 16) tinged with brownish yellow, the costal region clearer yellow; a vague dusky seam along the cord; veins yellow, the cord infuscated. Macrotrichia of veins long and conspicuous. Venation: Vein 2d A strongly sinuous.

Abdomen, including the hypopygium, yellow. Male hypopygium (Plate 2, fig. 33) with the median lobe of the tergite, *9t,* quadrate, transverse. Outer dististyle, *od,* with the inner blackened setiferous arm small, the outer arm unusually long and slender, subequal in length to the main axis of the style. Gonapophyses appearing as long, entirely pale, sword-shaped blades that narrow to acute points.

Habitat.—Formosa.

Holotype, male, Taihoku, May 8, 1929 (*S. Issiki*). Allotopotype, female. Paratopotype, female.

Erioptera ensifera belongs to a large group of Oriental species that are allied to *E. notata* de Meijere. It seems probable that this is the species recorded by Riedel as *E. flava* Brunetti,[2] from Taihoku. This species, which was later renamed *E. bengalensis* Alexander, is emphasized as having the halteres entirely pale and I cannot accept Brunetti's later conception that it is identical with *E. halterata* Brunetti, a Himalayan species with darkened halteres. The present species is certainly different from all other regional forms from low altitudes in the Malayan islands (*E. javanensis* de Meijere, *E. notata* de Meijere, *E. luzonica* Alexander).

ERIOPTERA (ILISIA) TENUISENTIS sp. nov.

Male.—Length, about 5 millimeters; wing, 5.7.

Closely allied to *E. (I.) asymmetrica* Alexander (Japan), differing especially in the structure of the male hypopygium.

Antennæ with the outer four or five segments infuscated. Mesonotal præscutum with the intermediate dark stripes narrow, entire. Dorsal pleural region more darkened. Legs with the fore and middle femora chiefly blackened, the subterminal yellow ring much reduced. Wings (Plate 1, fig. 17) with the pattern restricted to dark spots and dots along the veins. Male hypopygium (Plate 2, fig. 34) with the apical hooks of the ninth tergite, *9t,* very long and slender, strongly recurved, very gradually narrowed into long acute points. Gonapophyses, *g,* heavily

[2] Archiv für Naturgeschichte 82, Abt. A (1917) 113.

blackened, gradually narrowed to acute points, the mesal face not dilated.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,300 feet, July 7, 1929 (*S. Issiki*).

The subgenus *Ilisia* is new to the fauna of Formosa.

ERIOPTERA (EMPEDA) MICROTRICHIATA sp. nov.

General coloration gray; halteres pale yellow throughout; legs brown; wings tinged with gray, the diffuse stigmal region darker; Sc long, Sc_1 ending beyond midlength of Rs; macrotrichia of veins relatively short; male hypopygium with both dististyles pale.

Male.—Length, about 3 millimeters; wing, 3.4 to 3.7.

Female.—Length, about 3.5 to 3.8 millimeters; wing, 4 to 4.2.

Rostrum and palpi brown. Antennæ dark throughout, in the male with very long verticils, as usual in the subgenus. Head dark gray.

Mesonotum gray, the anterior lateral pretergites restrictedly yellow. Halteres pale yellow. Legs with the coxæ and trochanters obscure yellow; remainder of legs brown, the terminal tarsal segments darker. Wings with a grayish tinge, the large diffuse stigma darker; veins brown. Macrotrichia of veins short and inconspicuous. Venation: Sc long, Sc_1 ending just beyond midlength of the relatively long Rs; Sc_1 subequal to r-m; R_2 subequal to or a little shorter than R_{2+3+4}; cell R_3 relatively deep for a member of the subgenus.

Abdomen dark brown, including the hypopygium. Male hypopygium (Plate 2, fig. 35) with the dististyles pale, the outer dististyle, *od*, deeply bifid, the outer arm longest, curved to an acute point, the outer surface roughened; inner arm expanded at apex, the outer angle produced into a point. Gonapophyses, *g*, blackened.

Habitat.—Japan (Kiushiu).

Holotype, male, Mount Kirishima, altitude 2,500 feet, May 3, 1929 (*S. Issiki*). Allotopotype, female; paratopotypes, 2 males, females. Paratypes, 3 males, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*).

Erioptera (*Empeda*) *microtrichiata* is distinguished from *E.* (*E.*) *japonica* Alexander by the short macrotrichia of the wing veins and the uniformly pale halteres. It differs from *E.* (*E.*) *angustistigma* sp. nov. in the grayish wings and paler legs.

ERIOPTERA (EMPEDA) ANGUSTISTIGMA sp. nov.

General coloration gray; mouth parts and antennæ black; halteres pale yellow; legs black; wings light yellow with a narrow brown stigma; Sc long, Sc_1 extending to beyond midlength of Rs.

Female.—Length, about 3.8 millimeters; wing, 4.

Rostrum and palpi black. Antennæ short, black throughout. Head gray.

Anterior lateral pretergites dusky, the lateral margins clearer yellow. Mesonotum gray, the humeral region of the præscutum more reddish gray; pseudosutural foveæ reddish brown, the tuberculate pits darker. Pleura dark plumbeous gray, including the dorsopleural region. Halteres pale yellow throughout, clothed with silken golden setæ. Legs with the coxæ brown, the fore coxæ darker brown; trochanters brownish testaceous; remainder of legs brownish black. Wings (Plate 1, fig. 18) light yellow, with a narrow but well-defined brownish stigma; veins darker yellow than the ground color. Macrotrichia of veins relatively short and inconspicuous, brown. Venation: Sc long, Sc_1 ending beyond midlength of Rs, relatively short; R_{2+3+4} a little longer than R_2 and approximately three times R_{2+3}; cell M_2 open by the atrophy of m; m-cu at fork of M.

Abdomen dark brown; tergal valves of ovipositor broken; sternal valves blackened, long and straight.

Habitat.—Formosa.

Holotype, female, Arisan, altitude 7,300 feet, July 7, 1929 (*S. Issiki*).

Erioptera (*Empeda*) *angustistigma* differs from the known Formosan species in the coloration and wing venation. It is more closely allied to a small group of species known from the main islands of Japan, differing in the diagnostic features listed above.

MOLOPHILUS NIGRITUS sp. nov.

General coloration black; halteres dark brown; wings strongly tinged with blackish.

Female.—Length, about 4.5 to 5 millimeters; wing, 4.5 to 5.

Rostrum, palpi, and antennæ entirely black; flagellar segments subcylindrical, passing into long-oval; terminal segment smaller than the penultimate; verticils somewhat longer than the segments. Head black, sparsely gray pruinose, especially in front and on the posterior orbits.

Mesonotum black. Pleura black, sparsely pruinose. Halteres dark brown throughout. Legs black. Wings with a blackish tinge, the base not brightened; veins and macrotrichia darker. Venation: Vein 2d A gently sinuous, ending about opposite the caudal end of m-cu.

Abdomen black, the bases of the valves of the ovipositor similarly colored, the remainder of the long slender valves yellowish horn color.

Habitat.—Formosa.

Holotype, female, Arisan, altitude 7,300 feet, July 7, 1929 (*S. Issiki*). Paratopotypes, 1 female with type; 1 female, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*).

Molophilus nigritus is readily distinguished from regional species by the coloration. It is most similar to *M. trifilatus* Alexander (Japan), differing in the coloration of the wings and legs.

MOLOPHILUS NIGRITARSIS sp. nov.

Female.—Length, about 4 millimeters; wing, 4.3.

Closely allied to *M. costalis* Edwards (Formosa), differing especially in the coloration of the body and legs.

Rostrum and palpi black. Basal segments of antennæ yellow, the remainder darkened. Head yellow, the center of the vertex with a conspicuous brown area. Anterior lateral pretergites and extreme lateral margins of the præscutum sulphur yellow. Mesonotum plumbeous brown. Pleura chiefly dark brown, the pleurotergite more yellow, bearing a group of long yellow setæ. Halteres yellow. Legs with the fore coxæ darker than the middle and hind coxæ; forelegs brownish black; middle femora and tibiæ yellow, the tips of the latter and all tarsi blackened; posterior femora extensively infuscated, the narrow tips and broader bases yellowish; tibiæ bright yellow, the tips and all of tarsi blackened. Wings grayish, the prearcular and costal regions light yellow, this coloration including the veins and macrotrichia; remaining veins and macrotrichia dark, excepting vein Cu which is yellow. Abdomen brown, the caudal margins of the segments narrowly and indistinctly more yellowish.

Habitat.—Formosa.

Holotype, female, Arisan, altitude 7,300 feet, July 7, 1929 (*S. Issiki*).

The pattern of the legs is distinctive of more than a single species in the Formosan fauna.

ILLUSTRATIONS

[Legend; *a*, ædeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *s*, sternite; *t*, tergite; *vd*, ventral dististyle. Hypopygial terminology used, Crampton.]

PLATE 1

FIG. 1. *Limonia* (*Geranomyia*) *radialis* sp. nov., wing.
2. *Limonia* (*Geranomyia*) *alpestris* sp. nov., wing.
3. *Helius chikurinensis* sp. nov., wing.
4. *Tricyphona baikalica* sp. nov., wing.
5. *Tricyphona yakushimiana* sp. nov., wing.
6. *Ula flavidibasis* sp. nov., wing.
7. *Adelphomyia ariana* sp. nov., wing.
8. *Pseudolimnophila chikurina* sp. nov., wing.
9. *Nippolimnophila kiusiuensis* sp. nov., wing.
10. *Nippolimnophila yakushimensis* sp. nov., wing.
11. *Ulomorpha polytricha* sp. nov., wing.
12. *Ceratocheilus tinctipennis* sp. nov., wing.
13. *Lipsothrix yakushimae* sp. nov., wing.
14. *Gonomyia* (*Ptilostena*) *curticellula* sp. nov., wing.
15. *Gonomyia* (*Ptilostena*) *pruinosa* Alexander, wing.
16. *Erioptera* (*Erioptera*) *ensifera* sp. nov., wing.
17. *Erioptera* (*Ilisia*) *tenuisentis* sp. nov., wing.
18. *Erioptera* (*Empeda*) *angustistigma* sp. nov., wing.

PLATE 2

FIG. 19. *Tipula uénoi* sp. nov., male hypopygium, lateral.
20. *Tipula uénoi* sp. nov., male hypopygium, ninth tergite.
21. *Tipula uénoi* sp. nov., male hypopygium, eighth sternite.
22. *Limonia* (*Libnotes*) *recurvinervis* sp. nov., male hypopygium.
23. *Limonia* (*Geranomyia*) *radialis* sp. nov., male hypopygium.
24. *Helius chikurinensis* sp. nov., male hypopygium.
25. *Helius chikurinensis minusculus* subsp. nov., male hypopygium, gonapophysis.
26. *Tricyphona baikalica* sp. nov., male hypopygium.
27. *Tricyphona yakushimana* sp. nov., male hypopygium.
28. *Adelphomyia ariana* sp. nov., male hypopygium.
29. *Nippolimnophila kiusiuensis* sp. nov., antenna.
30. *Nippolimnophila kiusiuensis* sp. nov., male hypopygium.
31. *Gonomyia* (*Ptilostena*) *curticellula* sp. nov., male hypopygium.
32. *Gonomyia* (*Ptilostena*) *shantungensis* sp. nov., male hypopygium.
33. *Erioptera* (*Erioptera*) *ensifera* sp. nov., male hypopygium.
34. *Erioptera* (*Ilisia*) *tenuisentis* sp. nov., male hypopygium.
35. *Erioptera* (*Empeda*) *microtrichiata* sp. nov., male hypopygium.

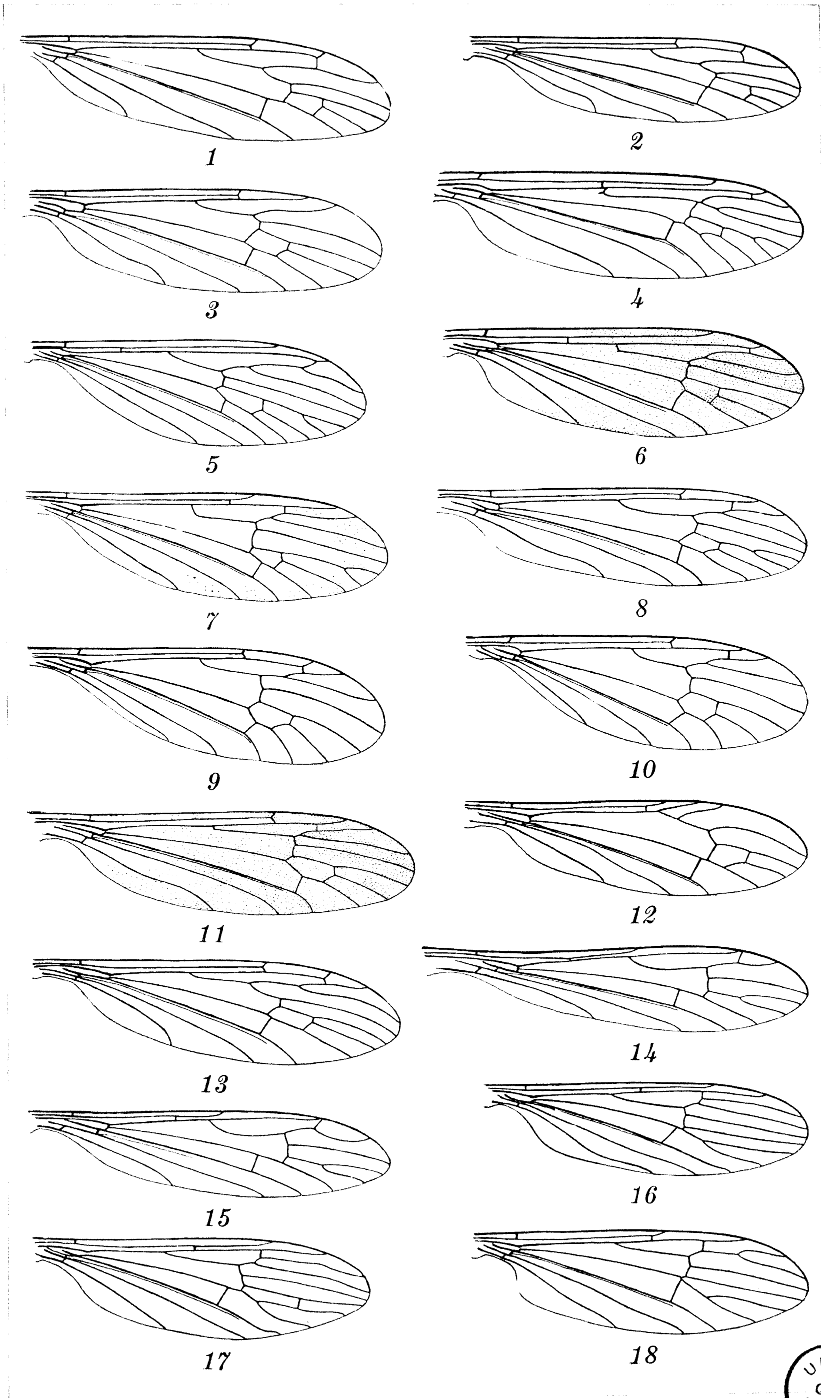

PLATE 1.

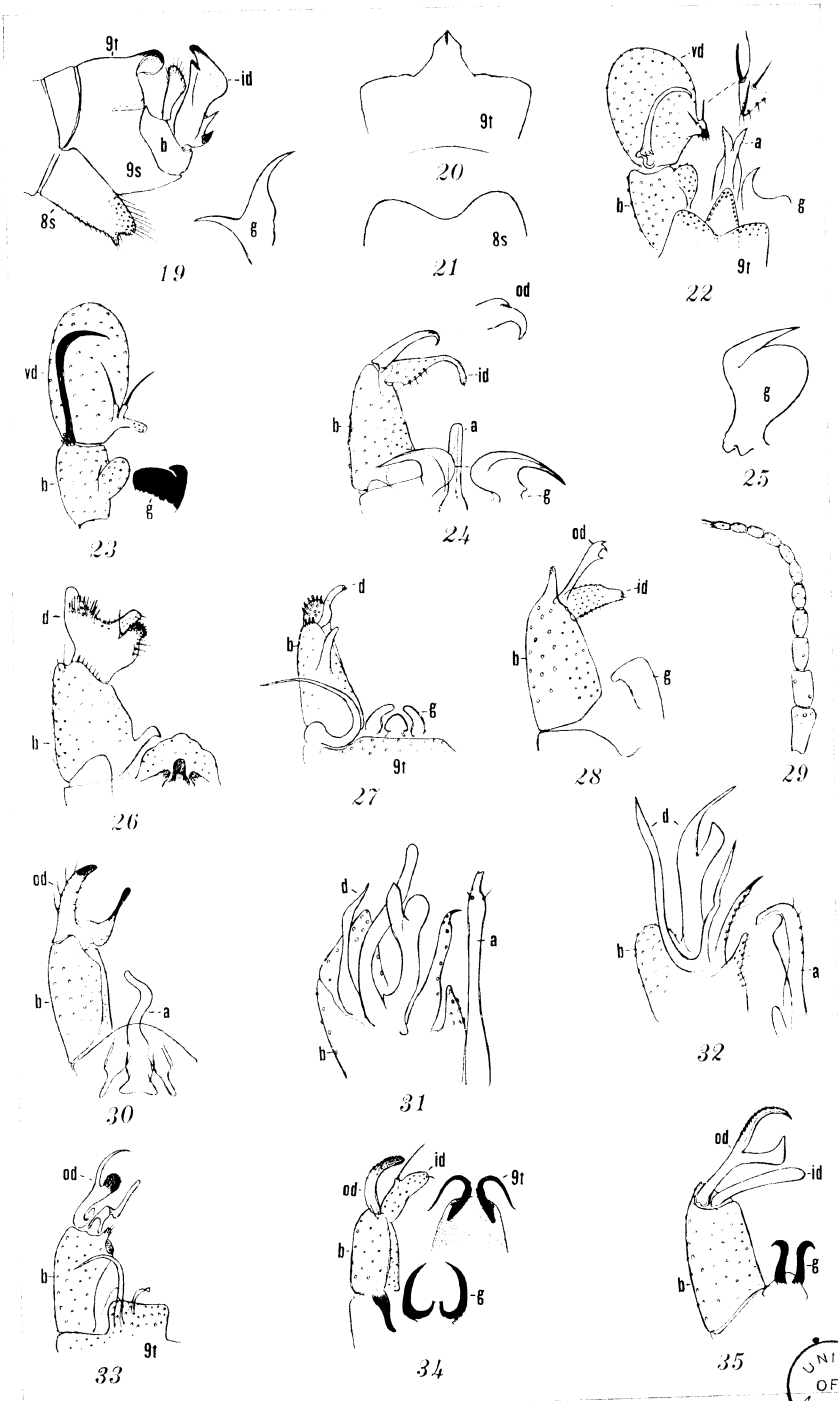
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PLATE 2.

SUMMARY OF PHILIPPINE LAND SHELLS

By Leopoldo A. Faustino

Of the Bureau of Science, Manila

The present list is to supplement Monograph 25 of the Philippine Bureau of Science, "Summary of Marine and Fresh-water Mollusks," and will include all species of land shells described or reported to occur in the Philippine Islands. Additional references are included, and lists of marine and fresh-water shells not included in the first publication are given in the form of Addenda.

6a.* Several catalogues of shells in the British Museum are here noted. These contain descriptions of genera and species with localities. Among the most important lists may be mentioned Louis Pfeiffer's Catalogue of Phaneropneumona, 1852; M. G. P. Deshayes's Catalogue of Conchifera, 1853; Louis Pfeiffer's Catalogue of Pulmonata, 1855, and Catalogue of Auriculidae, Proserpinidae, and Truncatellidae, 1857.

27a. Shortly after the death of Doctor Hidalgo, Florentino Azpeitia Moros wrote his "El Doctor Hidalgo y sus Publicaciones Malacológicas." This was followed by his paper entitled "Estudio de algunas especies de moluscos dedicados al Dr. Hidalgo por diversos autores, y de otras publicadas por dicho Doctor" presented to the Section of Natural Sciences of the Real Academia de Ciencias de Madrid and published in the Revista of the society in its issue of July, 1925.

32a. Other papers of Doctor Bartsch on Philippine shells follow:

A new Philippine land shell, Smithsonian Misc. Colls. 47, part 4, No. 1561 (1905) 409, pl. 56.

New land shells from the Philippines, Nautilus, 32 (1918) 15–16.

The land mollusks of the genus Obba from the islands of Bohol and Panglao, Journ. Washington Acad. Sci. 8 (1918) 16–17.

* Numbers refer to those used in the Introduction to Bureau of Science Monograph 25.

SUMMARY OF SPECIES

Class GASTROPODA

Subclass PULMONATA

Order STYLOMMATOPHORA

Suborder MONOTREMATA

Family STREPTAXIDÆ

Genus STREPTAXIS Gray

STREPTAXIS BOETTGERI Moellendorff. CEBU; NEGROS; GUIMARAS.
Senckenberg. Naturf. Ges. (1890) 190, pl. 7, fig. 1; Abh. Naturf. Ges. 22 (1898) 4.

Genus ENNEA H. and A. Adams

ENNEA BICOLOR Hutton. MANILA; CEBU; MINDANAO.
Reisen Philippinen 3 (1870) 250, pl. 8, fig. 14.

Genus DIAPHORA Albers

DIAPHORA ANCTOSTOMA Quadras and Moellendorff. CORON.
Nachrichbl. Malak. Ges. 27 (1895) 108.

DIAPHORA APTYCHIA Moellendorff. CALAMIANES.
Nachrichbl. Malak. Ges. 27 (1895) 152.

DIAPHORA CANALICULATA Quadras and Moellendorff. CALAMIANES.
Nachrichbl. Malak. Ges. 28 (1896) 82.

DIAPHORA CARDIOSTOMA Quadras and Moellendorff. MARINDUQUE.
Nachrichbl. Malak. Ges. 26 (1894) 82.

DIAPHORA CRISTATELLA Moellendorff. TABLAS.
Nachrichbl. Malak. Ges. 28 (1896) 1.

DIAPHORA CUMINGIANA Pfeiffer. TABLAS.
Man. Conchol. II 1 (1885) 107, pl. 20, fig. 23.

DIAPHORA CUSPIDATA Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 27 (1895) 105; Abh. Nat. Ges. 22 (1898) 5.

DIAPHORA CYLINDRICA Quadras and Moellendorff. MASBATE.
Nachrichbl. Malak. Ges. 27 (1895) 73.

DIAPHORA DEVIANS Moellendorff. CEBU.
Senckenberg. Naturf. Ges. (1890) 193, pl. 7, fig. 4; Abh. Naturf. Ges. 22 (1898) 6.

DIAPHORA DICRASPEDIA Moellendorff. BUSUANGA.
Ennea bicristata MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 84; Abh. Naturf. Ges. 22 (1898) 8.

DIAPHORA DILOPHIA Quadras and Moellendorff. CALAMIANES.
Nachrichbl. Malak. Ges. 27 (1895) 108.

DIAPHORA EULOPHIA Quadras and Moellendorff. CALAMIANES.
Nachrichbl. Malak. Ges. 27 (1895) 107.

DIAPHORA EURYOMPHALA Moellendorff. CAMARINES NORTE.
Nachrichbl. Malak. Ges. 27 (1895) 106.

DIAPHORA EUTRACHELA Moellendorff. CEBU.
Senckenberg. Naturf. Ges. (1890) 192, pl. 7, fig. 3; Abh. Naturf. Ges. 22 (1898) 6.

DIAPHORA HIDALGOI Moellendorff. BULACAN.
Nachrichbl. Malak. Ges. 20 (1888) 78; Abh. Naturf. Ges. 22 (1898) 5.

DIAPHORA HOMALOGYRA Quadras and Moellendorff. CALAMIANES.
Nachrichbl. Malak. Ges. 27 (1895) 107.

DIAPHORA KOCHIANA Moellendorff. CEBU.
Nachrichbl. Malak. Ges. 20 (1888) 79; Abh. Naturf. Ges. 22 (1898) 6.

DIAPHORA LOCARDI Hidalgo. LEYTE; NEGROS.
Senckenberg. Naturf. Ges. (1893) 60; Abh. Naturf. Ges. 22 (1898) 7.

DIAPHORA MACROSTOMA Quadras and Moellendorff. NEGROS.
Nachrichbl. Malak. Ges. 26 (1894) 82.

DIAPHORA MOELLENDORFFII Hidalgo. BUSUANGA.
Abh. Naturf. Ges. 22 (1898) 8.

DIAPHORA MORLETI Hidalgo. BUSUANGA.
Abh. Naturf. Ges. 22 (1898) 8.

DIAPHORA NITIDULA Quadras and Moellendorff. CATANDUANES.
Nachrichbl. Malak. Ges. 26 (1894) 81.

DIAPHORA OTOSTOMA Quadras and Moellendorff. CATANDUANES.
Nachrichbl. Malak. Ges. 26 (1894) 82.

DIAPHORA PLEISTOGYRA Quadras and Moellendorff. CALAMIANES.
Nachrichbl. Malak. Ges. 27 (1895) 109.

DIAPHORA QUADRASI Moellendorff. LEYTE; CEBU; GUIMARAS.
Senckenberg. Naturf. Ges. (1893) 60; Abh. Naturf. Ges. 22 (1898) 6.

DIAPHORA SAMARICA Moellendorff. SAMAR.
Nachrichbl. Malak. Ges. 28 (1896) 81.

DIAPHORA SERICINA Moellendorff. MONTALBAN, RIZAL.
Abh. Naturf. Ges. 22 (1898) 5.

DIAPHORA SOLENIDIUM Moellendorff. TABLAS.
Nachrichbl. Malak. Ges. 28 (1896) 2; Abh. Naturf. Ges. 22 (1898) 7.

DIAPHORA STRANGULATA Moellendorff. BUSUANGA.
Nachrichbl. Malak. Ges. 26 (1894) 83.

DIAPHORA STROPHOSTOMA Quadras and Moellendorff. CAGAYAN.
Nachrichbl. Malak. Ges. 28 (1896) 2.

DIAPHORA TELESCOPIUM Moellendorff. TABLAS.
Nachrichbl. Malak. Ges. 28 (1896) 2.

DIAPHORA TORTA Quadras and Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. 26 (1894) 83.

DIAPHORA TRUNCATELLA Moellendorff. PANAY.

Nachrichbl. Malak. Ges. 28 (1896) 82.

DIAPHORA TUBA Moellendorff. CEBU.

Abh. Naturf. Ges. 22 (1898) 7.

DIAPHORA UNICRISTATA Moellendorff. CORON.

Nachrichbl. Malak. Ges. 26 (1894) 84.

Family ZONITIDÆ

Genus VITRINA Draparnaud

VITRINA FASCIATA Souleyet. CENTRAL LUZON; LEYTE.

Man. Conchol. II 1 (1885) 158, pl. 35, figs. 26, 27. See *Vitrinopsis fasciata* SOULEYET, Obras Malacológicas (1890) 63, *Vitrinopsis planulata* PFEIFFER.

Genus VITRINOIDEA Semper

VITRINOIDEA ALBAIENSIS Semper. ALBAY.

Man. Conchol. II 1 (1885) 159, pl. 35, fig. 11; Abh. Naturf. Ges. 22 (1898) 9.

VITRINOIDEA QUADRASI Moellendorff. MASBATE.

Nachrichbl. Malak. Ges. 27 (1895) 74.

Genus VITRINOPSIS Semper

VITRINOPSIS APERTA Beck. CAGAYAN.

Vitrina aperta BECK, Proc. Zool. Soc. London (1848) 107; Conchol. Icon. 13 (1862) *Vitrina* pl. 10, fig. 71; Abh. Naturf. Ges. 22 (1898) 9. See *Helicarion apertus* Beck.

VITRINOPSIS BECKIANA Pfeiffer. GUIMARAS; NEGROS; SIQUIJOR.

Vitrina beckiana PFEIFFER, Proc. Zool. Soc. London (1848) 105; Conchol. Icon. 13 (1862) *Vitrina* pl. 4, fig. 22; Abh. Naturf. Ges. 22 (1898) 10. See *Halicarion beckianus* Pfeiffer.

VITRINOPSIS CEBUANA Moellendorff. CEBU.

Abh. Naturf. Ges. 22 (1898) 10.

VITRINOPSIS PAPILLATA Pfeiffer. RIZAL.

Abh. Naturf. Ges. 22 (1898) 10. See *Helicarion papillatus* Pfeiffer.

VITRINOPSIS PLANULATA Pfeiffer. LEYTE.

Senckenberg. Naturf. Ges. (1893) 60; Abh. Naturf. Ges. 22 (1898) 9. See *Vitrina fasciata* Souleyet.

VITRINOPSIS QUADRASI Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. 26 (1894) 84.

VITRINOPSIS TIGRINA Semper. NEAR MANILA.

Man. Conchol. II 1 (1885) 159, pl. 35, figs. 15, 16; Reisen Philippinen 3 (1870) 87, pl. 8, fig. 3; pl. 11, figs. 3, 4.

VITRINOPSIS TUBERCULATA Semper. BOHOL.

Man. Conchol. II 1 (1885) 159, pl. 35, fig. 14; Reisen Philippinen 3 (1870) 86, pl. 8, fig. 5; pl. 11, fig. 6, 26.

Genus VITRINOCONUS Semper

VITRINOCONUS ARCTISSIMUS Quadras and Moellendorff. NORTHERN TAYABAS.

Nachrichbl. Malak. Ges. 28 (1896) 3.

VITRINOCONUS ARCUATUS Pfeiffer. CAGAYAN.

Obras Malacológicas (1890) 65, *Helix arcuata* PFEIFFER, Proc. Zool. Soc. London (1846) 110; Conchol. Icon. 7 (1854) *Helix* pl. 37, figs. 169*a*, 169*b*. Man. Conchol. II 3 (1885–7) 46, pl. 5, fig. 84; 8 (1892) 296.

VITRINOCONUS CYATHELLUS Pfeiffer. LUZON; PANAY; BOHOL.

Obras Malacológicas (1890) 65, 100; Man. Conchol. II 1 (1885) 160, pl. 35, figs. 18, 19; *Helix cyathellus* PFEIFFER, Proc. Zool. Soc. London (1846) 41; Conchol. Icon. 7 (1854) *Helix* pl. 37, fig. 170.

VITRINOCONUS CYATHUS Pfeiffer. LUZON.

Obras Malacológicas (1890) 65; Man. Conchol. II 1 (1885) 160, pl. 35, figs. 20, 21; Reisen Philippinen 3 (1870) 92, pl. 11, fig. 24; *Helix cyathus* PFEIFFER, Proc. Zool. Soc. London (1845) 123; Conchol. Icon. 7 (1854) *Helix* pl. 33, fig. 139.

VITRINOCONUS DISCOIDEUS Semper. ANTIPOLO, RIZAL.

Man. Conchol. II 1 (1885) 161; Reisen Philippinen 3 (1870) 92.

VITRINOCONUS DOLIOLUM Pfeiffer. SIBONGA, CEBU.

Helix doliolum PFEIFFER, Proc. Zool. Soc. London (1846) 41; Conchol. Icon. 7 (1854) *Helix* pl. 43, figs. 196*a*, 196*b*; Man. Conchol. II 1 (1885) 160, pl. 35, fig. 23. See *Kaliella doliolum* Pfeiffer.

VITRINOCONUS GLABER Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 22 (1890) 201.

VITRINOCONUS GONIOMPHALUS Quadras and Moellendorff. CATANDUANES.

Nachrichbl. Malak. Ges. 26 (1894) 85.

VITRINOCONUS INFRACOSTATUS Moellendorff. BENGUET.

Nachrichbl. Malak. Ges. 28 (1896) 83.

VITRINOCONUS LATISSIMUS Moellendorff. CAGAYAN.

Nachrichbl. Malak. Ges. 25 (1893) 170.

VITRINOCONUS OMPHALOTROPIS Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 28 (1896) 3.

VITRINOCONUS QUADRASI Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 196, pl. 7, fig. 5; Abh. Naturf. Ges. 22 (1898) 11.

VITRINOCONUS SCALARINUS Pfeiffer. LEYTE.

Man. Conchol. II 1 (1885) 160, pl. 35, fig. 24.

VITRINOCONUS SINAITENSIS Pfeiffer. SINAIT, ILOCOS SUR.

Helix sinaitensis PFEIFFER, Proc. Zool. Soc. London (1845) 129; Conchol. Icon. 7 (1854) *Helix* pl. 204, pl. 1435; Man. Conchol. II 1 (1885) 160, pl. 35, fig. 22; Obras Malacológicas (1890) 66.

VITRINOCONUS SUTURALIS Moellendorff. LEYTE; BOHOL.

Senckenberg. Naturf. Ges. (1893) 61, pl. 3, figs. 1–1*b*. See *Euplecta suturalis* Moellendorff.

VITRINOCONUS TONGANUS Quoy and Gaimard. NEGROS.

Helix tongana QUOY and GAIMARD, Conchol. Icon. 7 (1854) *Helix* pl. 37, fig. 166; Man. Conchol. II 1 (1885) 161, pl. 35, fig. 25.

VITRINOCONUS TROCHISCUS Quadras and Moellendorff. CAGAYAN.

Nachrichbl. Malak. Ges. 25 (1893) 169.

VITRINOCONUS TURRITUS Semper. LUZON.

Man. Conchol. II 1 (1885) 161; Reisen Philippinen 3 (1870) 93. See *Euplecta turrita* Semper.

Genus MARIAELLA Gray

Subgenus TENNENTIA Humbert

MARIAELLA (TENNENTIA) CARINATA Moellendorff. SIBUYAN.

Nachrichbl. Malak. Ges. 26 (1894) 85.

MARIAELLA (TENNENTIA) PHILIPPINENSIS Semper. SURIGAO.

Man. Conchol. II 1 (1885) 162, pl. 36, figs. 43, 44; *Tennentia philippinensis* SEMPER, Reisen, Philippinen 3 (1870) 7, pl. 1, figs. 15, 16; pl. 3, fig. 1; pl. 5, figs. 3, 15–18; pl. 6, fig. 17.

MARIAELLA (TENNENTIA) QUADRASI Moellendorff. BUSUANGA.

Nachrichbl. Malak. Ges. 26 (1894) 85.

Genus HELICARION Férussac

HELICARION APERTUS Beck. CAGAYAN.

Vitrina aperta BECK, Proc. Zool. Soc. London (1848) 107; Conchol. Icon. 13 (1862) *Vitrina* pl. 10, fig. 71; Man. Conchol. II 1 (1885) 181, pl. 42, fig. 21; Cat. Pulmonata Brit. Mus. (1855) 73. See *Vitrinopsis aperta* Beck.

HELICARION ARAYATENSIS Semper. LUZON.

Man. Conchol. II 1 (1885) 184, pl. 43, figs. 59–61; ? *Mariælla arayatensis* SEMPER, Reisen Philippinen 3 (1870) 12, pl. 2, figs. 7*a–c*. See *Vitrinopsis planulata* Pfeiffer.

HELICARION BECKIANUS Pfeiffer. GUIMARAS; NEGROS; SIQUIJOR.

Vitrina beckiana PFEIFFER, Proc. Zool. Soc. London (1848) 105; Conchol. Icon. 13 (1862) *Vitrina* pl. 4, fig. 22; Man. Conchol. II 1 (1885) 173, pl. 39, figs. 81–83. See *Vitrinopsis beckiana* Pfeiffer.

HELICARION BICARINATUS Semper. BATANES.

Man. Conchol. II 1 (1885) 174, pl. 39, fig. 99; Reisen Philippinen 3 (1870) 29, pl. 1, fig. 8; pl. 3, figs. 12*a–c*; pl. 6, fig. 7.

HELICARION BICOLOR Beck. MARINDUQUE; GUIMARAS.

Vitrina bicolor BECK, Proc. Zool. Soc. London (1848) 104; Conchol. Icon. 13 (1862) *Vitrina* pl. 4, fig. 28; Man. Conchol. II 1 (1885) 174.

HELICARION CRENULARIS Beck. NEGROS; LEYTE; BATANES.

Man. Conchol. II 1 (1885) 174, pl. 39, figs. 3–5; Reisen Philippinen 3 (1870) 25, pl. 4, fig. 16; pl. 6, fig. 2. *Vitrina crenularis* BECK, Proc. Zool. Soc. London (1848) 106; Conchol. Icon. 13 (1862) *Vitrina* pl. 4, fig. 26.

HELICARION CUMINGII Beck. BOHOL.

Vitrina cumingii BECK, Proc. Zool. Soc. London (1848) 104; Conchol. Icon. 13 (1862) *Vitrina* pl. 3, figs. 19*a*, 19*b*; Man. Conchol. II 1 (1885) 172, pl. 39, fig. 77; *Xesta cumingi* BECK, Reisen Philippinen 3 (1870) 56, pl. 1, fig. 4; pl. 3, fig. 29; pl. 4, fig. 5; pl. 5, figs. 5–10; pl. 6, fig. 28.

HELICARION GUIMARASENSIS Pfeiffer. GUIMARAS.

Vitrina guimarasensis PFEIFFER, Proc. Zool. Soc. London (1848) 104; Conchol. Icon. 13 (1862) *Vitrina* pl. 5, fig. 35; Man. Conchol. II 1 (1885) 173, pl. 39, figs. 78–80.

HELICARION GUTTA Pfeiffer. BATANES; SORSOGON.

Vitrina gutta PFEIFFER, Proc. Zool. Soc. London (1848) 105; Conchol. Icon. 13 (1862) *Vitrina* pl. 6, fig. 44; Man. Conchol. II 1 (1885) 174, pl. 39, figs. 96–98; Reisen Philippinen 3 (1870) 24, pl. 1, fig. 11; pl. 6, fig. 1.

HELICARION HELICOIDES Semper. CAMIGUIN, LUZON.

Man. Conchol. II 1 (1885) 174; Reisen Philippinen 3 (1870) 24, pl. 4, figs. 14, 15; pl. 6, fig. 9. See *Macrochlamys helicoides* Semper.

HELICARION INCERTUS Semper. CEBU.

Man. Conchol. II 1 (1885) 174, pl. 39, fig. 6; Reisen Philippinen 3 (1870) 26, pl. 1, fig. 9; pl. 4, fig. 17; pl. 6, fig. 5.

HELICARION LEYTENSIS Beck. LEYTE; SIQUIJOR; DAVAO.

Vitrina leytensis BECK, Proc. Zool. Soc. London (1848) 105; Conchol. Icon. 13 (1862) *Vitrina* pl. 4, fig. 23; Man. Conchol. II 1 (1885) 173, pl. 39, figs. 87–89.

HELICARION LUZONICUS Pfeiffer. SORSOGON.

Vitrina luzonica PFEIFFER, Proc. Zool. Soc. London (1849) 132; Conchol. Icon. 13 (1862) *Vitrina* pl. 6, fig. 39; Man. Conchol. II 1 (1885) 174.

HELICARION MARGARITA Beck. GUIMARAS; CEBU; LEYTE.

Vitrina margarita BECK, Proc. Zool. Soc. London (1848) 104, Conchol. Icon. 13 (1862) *Vitrina* pl. 5, fig. 34; Man. Conchol. II 1 (1885) 173, pl. 39, figs. 90–92; Reisen Philippinen 3 (1870) 27, pl. 4, figs. 18*a*, *b*; pl. 6, fig. 3.

HELICARION MOLLIS Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 28 (1896) 4.

HELICARION PAPILLATUS Pfeiffer. LAGUNA.

Vitrina papillata PFEIFFER, Proc. Zool. Soc. London (1848) 106; Conchol. Icon. 13 (1862) *Vitrina* pl. 5, fig. 31; Man. Conchol. II 1 (1885) 184, pl. 43, fig. 63; Cat. Pulmonata Brit. Mus. (1855) 72. See *Vitrinopsis papillata* Pfeiffer.

HELICARION PAPILLIFER Quadras and Moellendorff. MASBATE.

Nachrichbl. Malak. Ges. 27 (1895) 74.

HELICARION PLANULATUS Pfeiffer. LAGUNA.

Vitrina planulata PFEIFFER, Proc. Zool. Soc. London (1848) 106; Conchol. Icon. 13 (1862) *Vitrina* pl. 5, fig. 3; Man. Conchol. II 1 (1885) 184, pl. 43, fig. 62; Cat. Pulmonata Brit. Mus. (1855) 72. See *Vitrinopsis planulata* Pfeiffer.

HELICARION POLITISSIMUS Beck. NEGROS; CEBU; SURIGAO.

Vitrina politissima BECK, Proc. Zool. Soc. London (1848) 105; Conchol. Icon. 13 (1862) *Vitrina* pl. 5, fig. 36; Man. Conchol. II 1 (1885) 173, pl. 39, figs. 84–86; Reisen Philippinen 3 (1870) 28, pl. 4, figs. 19*a*, *b*; pl. 6, fig. 8.

HELICARION QUADRASI Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. 26 (1894) 85.

HELICARION RESILIENS Beck. LUZON; CEBU.

Vitrina resiliens BECK, Proc. Zool. Soc. London (1848) 106; Conchol. Icon. 13 (1862) *Vitrina* pl. 4, fig. 27; Man. Conchol. II 1 (1885) 174; Reisen Philippinen 3 (1870) 26, pl. 1, fig. 10; pl. 6, fig. 23.

HELICARION RUFESCENS Pfeiffer. MINDORO.

Vitrina rufescens PFEIFFER, Proc. Zool. Soc. London (1848) 106; Conchol. Icon. 13 (1862) *Vitrina* pl. 5, fig. 29; Man. Conchol. II 1 (1885) 174, pl. 39, figs. 100, 1, 2.

HELICARION SMARAGDULUS Beck. NEGROS.

Vitrina smaragdulus BECK, Proc. Zool. Soc. London (1848) 104; Conchol. Icon. 13 (1862) *Vitrina* pl. 6, fig. 43; Man. Conchol. II 1 (1885) 174.

HELICARION TIGRINUS Semper. SURIGAO.

Man. Conchol. II 1 (1885) 173, pl. 39, figs. 93–95; Reisen Philippinen 3 (1870) 28, pl. 1, fig. 13; pl. 2, figs. 13*a*, *b*; pl. 6, figs. 20*a*, *b*; pl. 6, fig. 4.

Genus ARIOPHANTA Desmoulins

ARIOPHANTA BALESTERIANA Lea. PHILIPPINES.

Helix balesteriana LEA, Trans. Am. Phil. Soc. Phila. 10 (1852) 6, pl. 12, fig. 10.

Genus RHYSOTA Albers

RHYSOTA ANTONII Semper. LUZON.

Man. Conchol. II 2 (1885) 32, pl. 11, fig. 44; Reisen Philippinen 3 (1870) 72, pl. 2, figs. 2*a*, *b*.

RHYSOTA BLAINVILLEANA Lea. LUBANG; PANAY.

Helix blainvilleana LEA, Trans. Am. Phil. Soc. Phila. 10 (1852) 9, pl. 12, fig. 15; Man. Conchol. II 2 (1885) 44, pl. 15, figs. 1, 2; *Rhysota semigranosa* SOWERBY, Reisen Philippinen 3 (1870) 74; *Rhysota moussoni* SEMPER, 75; *Helix semigranosa* SOWERBY, Proc. Zool. Soc. London (1841) 26; Conchol. Icon. 7 (1854) *Helix* pl. 27, figs. 115, 117*a*, 117*b*. See *Hemiglypta blainvilleana* Lea, *Hemiglypta moussoni* Semper.

RHYSOTA BULLA Pfeiffer. ALBAY.

Helix bulla PFEIFFER, Proc. Zool. Soc. London (1842) 151; Conchol. Icon. 7 (1854) *Helix* pl. 4, fig. 15; Man. Conchol. II 2 (1885) 37, pl. 12, figs. 60, 61; Reisen Philippinen 3 (1870) 72, pl. 1, fig. 3; pl. 4, fig. 13; pl. 7, fig. 14.

RHYSOTA CUVIERIANA Lea. CAMARINES SUR.

Helix cuvieriana LEA, Trans. Am. Phil. Soc. Phila. 10 (1852) 7, pl. 12, fig. 12; Conchol. Icon. 7 (1854) *Helix* pl. 7, fig. 38; Man. Conchol. II 2 (1885) 38, pl. 13, figs. 65, 66. See *Hemiglypta cuvieriana* Lea.

RHYSOTA DARONDEAUI Souleyet. BATAAN.

Man. Conchol. II 2 (1885) 40, pl. 13, fig. 74.

RHYSOTA DENSA Adams and Reeve. PHILIPPINES.

Helix densa ADAMS and REEVE, H. M. S. Samarang Voy. Zool. Publ. London (1850) 62, pl. 16, fig. 8; Conchol. Icon. 7 (1854) *Helix* pl. 73, fig. 375; Man. Conchol. II 2 (1885) 42, pl. 14, figs. 91–93.

RHYSOTA DISTINCTA Pfeiffer. ZAMBOANGA; LEYTE.

Nanina distincta PFEIFFER, Obras Malacológicas (1890) 75.

RHYSOTA DVITIJA Semper. MOUNTAIN PROVINCE.

Man. Conchol. II 2 (1885) 29, pl. 8, fig. 24; Reisen Philippinen 3 (1870) 70, pl. 4, fig. 8; pl. 7, fig. 16.

RHYSOTA EGERIA Smith. PALAWAN.

Abh. Naturf. Ges. 22 (1898) 39.

RHYSOTA EXILIS Müller. TICAO.

Helix exilis MÜLLER, Conchol. Icon. 7 (1854) *Helix* pl. 4, fig. 16; Man. Conchol. II 2 (1885) 38, pl. 13, figs. 67, 68.

RHYSOTA GERVAISII Dubrueil. MINDANAO.

Man. Conchol. II 2 (1885) 31, pl. 9, fig. 35.

RHYSOTA GLOBOSA Semper. SURIGAO.

Man. Conchol. II 2 (1885) 35, pl. 7, fig. 13; Reisen Philippinen 3 (1870) 75, pl. 2, figs. 3*a–c*. See *Hemiglypta globosa* Semper.

RHYSOTA HEPATICA Reeve. ZAMBALES.

Helix hepatica REEVE, Conchol. Icon. 7 (1854) *Helix* pl. 3, fig. 9; Abh. Naturf. Ges. 22 (1898) 39. See *Rhysota sagittifera* Pfeiffer.

RHYSOTA LAMARCKIANA Lea. MASBATE; CEBU.

Helix lamarckiana LEA, Trans. Am. Phil. Soc. Phila. 10 (1852) 7, pl. 12, fig. 11; Conchol. Icon. 7 (1854) *Helix* pl. 4, fig. 20; Man. Conchol. II 2 (1885) 32, pl. 10, figs. 40, 41; *Helix caducior* REEVE, Conchol. Icon. 7 (1854) *Helix* pl. 3, fig. 12.

RHYSOTA MAXIMA Pfeiffer. MINDANAO.

Helix maxima PFEIFFER, Proc. Zool. Soc. London (1853) 48; Conchol. Icon. 7 (1854) *Helix* pl. 155, fig. 1015; Man. Conchol. II 2 (1885) 31, pl. 10, fig. 38; Reisen Philippinen 3 (1870) 69, pl. 7, fig. 13.

RHYSOTA MINDANAENSIS Semper. MINDANAO.

Man. Conchol. II 2 (1885) 30, pl. 9, fig. 31; *Xesta mindanaensis* SEMPER, Reisen Philippinen 3 (1870) 61, pl. 1, fig. 1; pl. 2, figs. 1*a*, *b*; pl. 3, fig. 14; pl. 7, fig. 12.

RHYSOTA MUELLERI Pfeiffer. MINDORO.

Helix muelleri PFEIFFER, Conchol. Icon. 7 (1854) *Helix* pl. 4, fig. 19; Man. Conchol. II 2 (1885) 31, pl. 10, fig. 37; Abh. Naturf. Ges. 22 (1898) 42.

RHYSOTA NIGRESCENS Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 41; Nachrichbl. Malak. Ges. 20 (1888) 86.

RHYSOTA NOBILIS Pfeiffer. ZAMBOANGA.

Helix nobilis PFEIFFER, Proc. Zool. Soc. London (1849) 127; Conchol. Icon. 7 (1854) *Helix* pl. 74, fig. 381; Cat. Pulmonata Brit. Mus. (1855) 105; Abh. Naturf. Ges. 22 (1898) 39.

RHYSOTA OVUM Valenciennes. LUZON; PANAY.

Helix ovum VALENCIENNES, Conchol. Icon. 7 (1854) *Helix* pl. 1, figs. 1, 2, 4; Man. Conchol. II 2 (1885) 30, pl. 8, fig. 29; Reisen Philippinen 3 (1870) 69, pl. 4, fig. 1.

RHYSOTA OWENIANA Pfeiffer. CEBU; MINDANAO.

Helix oweniana PFEIFFER, Proc. Zool. Soc. London (1853) 49; Conchol. Icon. 7 (1854) *Helix* pl. 155, fig. 1013; Man. Conchol. II 2 (1885) 32, pl. 10, fig. 39.

RHYSOTA PANAYENSIS Broderip. LUZON; PANAY.

Helix panayensis BRODERIP, Proc. Zool. Soc. London (1842) 66; Man. Conchol. II 2 (1885) 44, pl. 14, figs. 96, 97. See *Hemiglypta panayensis* Brod.

RHYSOTA PORPHYRIA Pfeiffer. BURIAS.

Helix porphyria PFEIFFER, Proc. Zool. Soc. London (1842) 87; Conchol. Icon. 7 (1854) *Helix* pl. 3, fig. 8; Man. Conchol. II 2 (1885) 32, pl. 10, fig. 42; Reisen Philippinen 3 (1870) 70, pl. 5, fig. 22; pl. 7, fig. 6.

RHYSOTA QUADRASI Hidalgo. CATANDUANES.

Nanina quadrasi HIDALGO, Obras Malacológicas (1890) 20; Abh. Naturf. Ges. 22 (1898) 43.

RHYSOTA RHEA Pfeiffer. ILOILO.

Helix rhea PFEIFFER, Proc. Zool. Soc. London (1855) 111; Man. Conchol. II 2 (1885) 30, pl. 9, fig. 30.

RHYSOTA SAGITTIFERA Pfeiffer. LUZON.

Helix sagittifera PFEIFFER, Proc. Zool. Soc. London (1842) 86; Conchol. Icon. 7 (1854) *Helix* pl. 1, fig. 3; Man. Conchol. II 2 (1885) 29, pl. 7, figs. 18–20.

RHYSOTA SCHUMACHERIANA Pfeiffer. PALAWAN.

Nanina schumacheriana PFEIFFER, Obras Malacológicas (1890) 76.

RHYSOTA SEMIGLOBOSA Pfeiffer. CAMARINES SUR; LEYTE; SAMAR; MINDANAO.

Helix semiglobosa PFEIFFER, Proc. Zool. Soc. London (1845) 38; Conchol. Icon. 7 (1854) *Helix* pl. 27, fig. 118; Man. Conchol. II 2 (1885) 43, pl. 14, fig. 95; Reisen Philippinen 3 (1870) 73, pl. 1, fig. 2; pl. 4, fig. 7; pl. 7, fig. 15. See *Hemiglypta semiglobosa* Pfeiffer.

RHYSOTA STOLEPHORA Valenciennes. LUZON; MINDORO; CEBU.

Man. Conchol. II 2 (1885) 29, pl. 7, fig. 17.

RHYSOTA STRIATULA Semper. ILOCOS SUR.

Man. Conchol. II 2 (1885) 35, pl. 7, figs. 10–12; Reisen Philippinen 3 (1870) 77, pl. 2, figs. 4*a–c*. See *Hemitrichia striatula* Semper.

RHYSOTA URANUS Pfeiffer. POLILLO.

Helix uranus PFEIFFER, Proc. Zool. Soc. London (1861) 190; Man. Conchol. II 2 (1885) 33, pl. 11, fig. 45.

RHYSOTA ZEUS Jonas. MINDORO; TABLAS; ROMBLON.

Helix zeus JONAS, Proc. Zool. Soc. London (1842) 188; Conchol. Icon. 7 (1854) *Helix* pl. 4, fig. 17; Man. Conchol. II 2 (1885) 32, pl. 11, fig. 46.

Genus EUPLECTA Semper

EUPLECTA ARMIDA Pfeiffer. LUZON.

Helix armida PFEIFFER, Proc. Zool. Soc. London (1853) 58; Conchol. Icon. 7 (1854) *Helix* pl. 157, fig. 1032; Man. Conchol. II 2 (1885) 46, pl. 23, fig. 49.

EUPLECTA AZPEITIAE Hidalgo. CATANDUANES.

Inozonites azpeitiae HIDALGO, Abh. Naturf. Ges. 22 (1898) 47.

EUPLECTA BARTSCHI n.n. BOHOL.

Inozonites quadrasi MOELLENDORFF, Nachrichbl. Malak. Ges. 28 (1896) 85. Not *Euplecta quadrasi* Moellendorff, Senckenberg. Naturf. Ges. (1893) 63, pl. 3, figs. 2, 2*a*.

EUPLECTA BATHYRAPHE Moellendorff. LUZON.

Inozonites bathyraphe MOELLENDORFF, Nachrichbl. Malak. Ges. 27 (1895) 113.

EUPLECTA BIANGULATA Pfeiffer. LUZON.

Helix biangulata PFEIFFER, Proc. Zool. Soc. London (1845) 40; Conchol. Icon. 7 (1854) *Helix* pl. 35, figs. 157*a*, 157*b*; Man. Conchol. II 2 (1885) 46, pl. 23, fig. 50.

EUPLECTA BICARINATA Semper. LUZON.

Man. Conchol. II 2 (1885) 46, pl. 23, figs. 52, 53; Reisen Philippinen 3 (1870) 16, pl. 2, figs. 8*a–c*.

EUPLECTA BOHOLENSIS Pfeiffer. BOHOL.

Helix boholensis PFEIFFER, Proc. Zool. Soc. London (1845) 123; Conchol. Icon. 7 (1854) *Helix* pl. 35, figs. 154*a*, 154*b*; Man. Conchol. II 2 (1885) 46, pl. 23, figs. 47, 48.

EUPLECTA BOHOLICA Quadras and Moellendorff. BOHOL.

Coneuplecta boholica QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 28 (1896) 84.

EUPLECTA CANALIFERA Moellendorff. SAMAR.

Nachrichbl. Malak. Ges. 28 (1896) 83.

EUPLECTA CARINARIA Moellendorff. BULACAN; RIZAL.

Nachrichbl. Malak. Ges. 20 (1888) 143.

EUPLECTA CATANDUANICA Quadras and Moellendorff. CATANDUANES.

Nachrichbl. Malak. Ges. 26 (1894) 88.

EUPLECTA CEBUENSIS Moellendorff. CEBU.

Medyla cebuensis MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 19.

EUPLECTA CONFUSA Moellendorff. PANAY; BOHOL; MINDANAO.

Medyla confusa MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 20.

EUPLECTA CONICOIDES Metcalfe. PALAWAN.

Dendrotrochus conicoides METCALFE, Abh. Naturf. Ges. 22 (1898) 21.

EUPLECTA CONVEXOSPIRA Moellendorff. SIBUL, BULACAN.

Nachrichbl. Malak. Ges. 26 (1894) 87.

EUPLECTA COSTULATA Moellendorff. SIBUL, BULACAN.

Nachrichbl. Malak. Ges. 26 (1894) 88.

EUPLECTA CRYSTALLUS Quadras and Moellendorff. CALAMIANES.

Nachrichbl. Malak. Ges. 26 (1894) 89.

EUPLECTA DECUSSATULA Quadras and Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 27 (1895) 110.

EUPLECTA EXCAVATA Moellendorff. LUZON.

Medyla excavata MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 17.

EUPLECTA EXCENTRICA Pfeiffer. SIQUIJOR.

Medyla excentrica PFEIFFER, Abh. Naturf. Ges. 22 (1898) 17. See *Macrochlamys excentrica* Pfeiffer.

EUPLECTA FILOCINCTA Pfeiffer. MISAMIS.

Helix filocincta PFEIFFER, Proc. Zool. Soc. London (1845) 124; Conchol. Icon. 7 (1854) *Helix* pl. 36, fig. 158; Man. Conchol. II 2 (1885) 46, pl. 23, fig. 51.

EUPLECTA HYALINUS Moellendorff. CAMARINES NORTE.

Inozonites hyalinus MOELLENDORFF, Nachrichbl. Malak. Ges. 27 (1895) 113.

EUPLECTA KOCHIANA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 63, pl. 3, figs. 3–3*b*; Nachrichbl. Malak. Ges. 22 (1890) 190.

EUPLECTA MARGINATA Moellendorff. CEBU.

Medyla marginata MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 17; Senckenberg. Naturf. Ges. (1890) 202, pl. 7, fig. 7.

EUPLECTA NEMATOTROPIS Moellendorff. LUZON.

Inozonites nematotropis MOELLENDORFF, Nachrichbl. Malak. Ges. 27 (1895) 113.

EUPLECTA ORTHOSTOMA Pfeiffer. PANAY.

Helix orthostoma PFEIFFER, Proc. Zool. Soc. London (1845) 124; Conchol. Icon. 7 (1854) *Helix* pl. 36, figs. 159*a*, 159*b*; Man. Conchol. II 2 (1885) 47, pl. 23, figs. 54–56.

EUPLECTA PACIFICA Quadras and Moellendorff. TAYABAS.

Nachrichbl. Malak. Ges. 28 (1896) 4.

EUPLECTA PARAGUENSIS Smith. PALAWAN.

Dendrotrochus paraguensis SMITH, Abh. Naturf. Ges. 22 (1898) 21.

EUPLECTA QUADRASI Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 63, pl. 3, figs. 2, 2*a*.

EUPLECTA REYESI Hidalgo. LEYTE; SURIGAO.

Senckenberg. Naturf. Ges. (1893) 64.

EUPLECTA ROEBELENI Moellendorff. BUTUAN, AGUSAN.

Nachrichbl. Malak. Ges. 26 (1894) 88.

EUPLECTA ROTUNDATA Semper. LUZON.

Man. Conchol. II 2 (1885) 47.

EUPLECTA SCALARINA Pfeiffer. LEYTE.

Senckenberg. Naturf. Ges. (1893) 66.

EUPLECTA SPIRIPLANUS Moellendorff. MINDANAO.

Inozonites spiriplanus MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 47.

EUPLECTA STENOMPHALUS Quadras and Moellendorff. ISABELA.

Inozonites stenomphalus QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 28 (1896) 7.

EUPLECTA SUBTERRANEA Quadras and Moellendorff. BOHOL.

Nachrichbl. Malak. Ges. 28 (1896) 84.

EUPLECTA SUTURALIS Moellendorff. LEYTE; BOHOL.

Inozonites suturalis MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 47. See *Vitrinoconus suturalis* Möll.

EUPLECTA SYLVANA Dohrn and Semper. MINDANAO.

Nanina sylvana DOHRN and SEMPER, Man. Conchol. II 2 (1885) 49, pl. 23, figs. 69, 70; *Trochomorpha sylvana* DOHRN and SEMPER, Reisen Philippinen 3 (1870) 116; *Dendrotrochus sylvanus* DOHRN and SEMPER, Abh. Naturf. Ges. 22 (1898) 22.

EUPLECTA TURRITA Semper. LUZON.

Medyla turrita SEMPER, Abh. Naturf. Ges. 22 (1898) 20. See *Vitrinoconus turritus* Semper.

EUPLECTA UNICARINATA Quadras and Moellendorff. BATAAN.

Medyla unicarinata QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 27 (1895) 109.

Genus SITALA H. Adams

SITALA BARITENSIS Smith. PALAWAN.
Abh. Naturf. Ges. 22 (1898) 23.

SITALA DITROPIS Quadras and Moellendorff. MINDANAO.
Nachrichbl. Malak. Ges. 26 (1894) 101.

SITALA FIMBRIOSA Quadras and Moellendorff. NEGROS.
Nachrichbl. Malak. Ges. 26 (1894) 89.

SITALA LINEOLATA Moellendorff. LEYTE; SIQUIJOR.
Senckenberg. Naturf. Ges. (1893) 68.

SITALA ORCHIS Godwin-Austen. SIBUTU.
Ann. & Mag. Nat. Hist. XIII 6 (1894) 52.

SITALA OXYCONUS Moellendorff. CORON.
Nachrichbl. Malak. Ges. 26 (1894) 89.

SITALA PHILIPPINARUM Moellendorff. LEYTE; CEBU.
Senckenberg. Naturf. Ges. (1893) 68.

Genus KALIELLA Blanford

KALIELLA ACCEPTA Smith. PALAWAN.
Abh. Naturf. Ges. 22 (1898) 24.

KALIELLA CHONDRIUM Quadras and Moellendorff. ISABELA.
Nachrichbl. Malak. Ges. 28 (1896) 5.

KALIELLA DENTIFERA Quadras and Moellendorff. NEGROS.
Nachrichbl. Malak. Ges. 26 (1894) 90.

KALIELLA DOLIOLUM Pfeiffer. LUZON; CEBU; MINDANAO.
Abh. Naturf. Ges. 22 (1898) 25. See *Vitrinoconus doliolum* Pfeiffer.

KALIELLA INFANTILIS Smith. PALAWAN.
Abh. Naturf. Ges. 22 (1898) 24.

KALIELLA LEUCOTROPIS Quadras and Moellendorff. BOHOL.
Nachrichbl. Malak. Ges. 28 (1896) 84.

KALIELLA MICROPETASUS Quadras and Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 171.

KALIELLA MICROTHOLUS Moellendorff. CAMARINES SUR.
Nachrichbl. Malak. Ges. 27 (1895) 110.

KALIELLA OPACA Quadras and Moellendorff. ISABELA.
Nachrichbl. Malak. Ges. 28 (1896) 4.

KALIELLA PSEUDOSITALA Moellendorff. LEYTE; CEBU.
Senckenberg. Naturf. Ges. (1893) 68.

KALIELLA PUSILLA Moellendorff. LUZON; LEYTE; CEBU.
Nachrichbl. Malak. Ges. 20 (1888) 81; Senckenberg. Naturf. Ges. (1893) 69.

KALIELLA STENOPLEURIS Moellendorff. LUZON; CATANDUANES.
Abh. Naturf. Ges. 22 (1898) 24.

KALIELLA STYLODONTA Quadras and Moellendorff. CATANDUANES.

Nachrichbl. Malak. Ges. 27 (1895) 110.

KALIELLA TENUISCULPTA Moellendorff. LUZON; MARINDUQUE; LEYTE.

Senckenberg. Naturf. Ges. (1893) 69.

KALIELLA TRANSITANS Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 68, pl. 3, figs. 4–4*b*.

Genus GLYPTOCONUS Moellendorff

GLYPTOCONUS MIRUS Moellendorff. BUSUANGA.

Nachrichbl. Malak. Ges. 26 (1894) 90.

Genus XESTA Albers

XESTA CONOIDALIS Adams and Reeve. MINDORO.

Helix conoidalis ADAMS and REEVE, H.M.S. Samarang Voy. Zool. Publ. London (1850) 63, pl. 16, fig. 63; Conchol. Icon. 7 (1854) *Helix* pl. 96, fig. 523; Man. Conchol. II 2 (1885) 82, pl. 15, fig. 11.

XESTA FULVIDA Pfeiffer. MINDANAO.

Helix fulvida PFEIFFER, Proc. Zool. Soc. London (1842) 87; Conchol. Icon. 7 (1854) *Helix* pl. 7, fig. 29; Man. Conchol. II 2 (1885) 82, pl. 15, fig. 10.

XESTA LUTEOFASCIATA Lea. LUZON; MARINDUQUE.

Helix luteofasciata LEA, Trans. Am. Phil. Soc. Phila. 10 (1852) 8, pl. 12, fig. 8; Man. Conchol. II 2 (1885) 85, pl. 16, fig. 33; *Rhysota gummata* SOWERBY, Reisen Philippinen 3 (1870) 76, pl. 6, fig. 32; *Nanina gummata* SOWERBY, Obras Malacológicas (1890) 82, 105; *Helix gummata* SOWERBY, Proc. Zool. Soc. London (1841) 25; Conchol. Icon. 7 (1854) *Helix* pl. 31, figs. 134*a*, 134*b*. See *Hemitrichia luteofasciata* Lea.

XESTA MÖRCHII Pfeiffer. NEGROS.

Man. Conchol. II 2 (1885) 85, pl. 16, fig. 36. See *Hemitrichia moerchi* Pfeiffer.

XESTA SETIGERA Sowerby. LUZON.

Helix setigera SOWERBY, Proc. Zool. Soc. London (1841) 25; Conchol. Icon. 7 (1854) *Helix* pl. 31, fig. 135; Man. Conchol. II 2 (1885) 86, pl. 16, fig. 40; *Rhysota setigera* PFEIFFER, Reisen Philippinen 3 (1870) 76, pl. 6, fig. 33. See *Hemitrichia setigera* Sowerby.

XESTA TAGALENSIS Dohrn. LUZON.

Man. Conchol. II 2 (1885) 85, pl. 16, fig. 35. See *Hemitrichia tagalensis* Dohrn.

XESTA VELUTINA Sowerby. ALBAY; NEGROS.

Helix velutina SOWERBY, Proc. Zool. Soc. London (1841) 25; Man. Conchol. II 2 (1885) 85, pl. 16, fig. 34; *Rhysota xanthotricha* PFEIFFER, Reisen Philippinen 3 (1870) 77; *Helix xanthotricha* PFEIFFER, Conchol. Icon. 7 (1854) *Helix* pl. 31, figs. 132*a*–132*c*. See *Hemitrichia velutina* Sowerby.

Genus MACROCHLAMYS Benson

MACROCHLAMYS ALBA Moellendorff. CEBU.

Lamprocystis alba MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 28.

MACROCHLAMYS ANGULATA Moellendorff. SULU ARCHIPELAGO.

Ann. & Mag. Nat. Hist. XIII 6 (1894) 51, pl. 4, fig. 1.

MACROCHLAMYS APPENDICULATA Moellendorff. LEYTE.

Lamprocystis appendiculata MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 72, pl. 3, figs. 5–5*b*.

MACROCHLAMYS ARCTISPIRA Quadras and Moellendorff. MINDORO.

Lamprocystis arctispira QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 91.

MACROCHLAMYS BADIA Moellendorff. CEBU.

Lamprocystis badia MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 26; Senckenberg. Naturf. Ges. (1890) 206, pl. 7, fig. 8.

MACROCHLAMYS BISLIGENSIS Semper. MISAMIS; SURIGAO.

Man. Conchol. II 2 (1885) 105, pl. 35, figs. 29–31; *Helicarion bisligensis* SEMPER, Reisen Philippinen 3 (1870) 30, pl. 2, fig. 12*a–c;* pl. 4, figs. 21*a*, *b;* pl. 6, fig. 6.

MACROCHLAMYS CAGAYANICA Quadras and Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 170.

MACROCHLAMYS CALAMIANICA Quadras and Moellendorff. BUSUANGA.

Lamprocystis calamianica QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 91.

MACROCHLAMYS CANDIDA Quadras and Moellendorff. CATANDUANES.

Lamprocystis candida QUADRAS and MOELLENDORF, Nachrichbl. Malak. Ges. 26 (1894) 92.

MACROCHLAMYS CERATODES Pfeiffer. LUZON; MINDORO.

Helix ceratodes PFEIFFER, Proc. Zool. Soc. London (1845) 128; Conchol. Icon. 7 (1854) *Helix* pl. 34, fig. 150; Man. Conchol. II 2 (1885) 105, pl. 35, figs. 27, 28; *Helicarion ceratodes* PFEIFFER, Reisen Philippinen 3 (1870) 21, pl. 1, fig. 12; pl. 4, figs. 11, 22–25; pl. 6, fig. 24.

MACROCHLAMYS CHLORORHAPHE Smith. CALAMIANES; PALAWAN.

Lamprocystis chlororhaphe SMITH, Ann. & Mag. Nat. Hist. XI 6 (1893) 348, pl. 18, figs. 4–6; Abh. Naturf. Ges. 22 (1898) 26.

MACROCHLAMYS COMPACTA Quadras and Moellendorff. LUBANG ISLAND.

Nachrichbl. Malak. Ges. 26 (1894) 86.

MACROCHLAMYS CREBRISTRIATA Semper. BASILAN.

Man. Conchol. II 2 (1885) 104, pl. 35, figs. 22–24; ? *Macrochlamys crebristriatus* SEMPER, Reisen Philippinen 3 (1870) 18, pl. 2, figs. 6*a–c*.

MACROCHLAMYS CRYSTALLINA Moellendorff. MARINDUQUE; NEGROS; CEBU.

Lamprocystis crystallina MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 28.

MACROCHLAMYS DISCOIDEA Quadras and Moellendorff. BALABAC.

Lamprocystis discoidea QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 91.

MACROCHLAMYS EXCENTRICA Pfeiffer. SIQUIJOR.

Helix excentrica PFEIFFER, Proc. Zool. Soc. London (1845) 41; Conchol. Icon. 7 (1854) *Helix* pl. 34, fig. 152; Man. Conchol. II 2 (1885) 105, pl. 35, figs. 36, 37. See *Euplecta excentrica* Pfeiffer.

MACROCHLAMYS FASCIATA Moellendorff. BULACAN; RIZAL.

Nachrichbl. Malak. Ges. 20 (1888) 80.

MACROCHLAMYS GEMMA Pfeiffer. BATANES.

Helix gemma PFEIFFER, Proc. Zool. Soc. London (1848) 109; Conchol. Icon. 7 (1854) *Helix* pl. 37, fig. 168; Man. Conchol. II 2 (1885) 117, pl. 39, figs. 95–97.

MACROCHLAMYS GEMMULA Moellendorff. LUZON; LEYTE; CEBU.

Lamprocystis gemmula MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 72.

MACROCHLAMYS GLABERRIMA Semper. BATAAN.

Man. Conchol. II 2 (1885) 112, pl. 37, figs. 15–17; *Microcystis glaberrima* SEMPER, Reisen Philippinen 3 (1870) 46, pl. 2, figs. 10*a–c*.

MACROCHLAMYS GLOBULUS Moellendorff. CEBU; BOHOL.

Lamprocystis globulus MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 28.

MACROCHLAMYS GONIOGYRA Moellendorff. SIQUIJOR; PANGLAO.

Lamprocystis goniogyra MOELLENDORFF, Nachrichbl. Malak. Ges. 23 (1891) 41.

MACROCHLAMYS GRADATA Pfeiffer. LEYTE.

Nanina gradata PFEIFFER, Cat. Pulmonata Brit. Mus. (1855) 99; *Helix gradata* PFEIFFER, Proc. Zool. Soc. London (1846) 110; Conchol. Icon. 7 (1854) *Helix* pl. 37, figs. 165*a*, 165*b*.

MACROCHLAMYS HELICOIDES Semper. BATANES.

Abh. Naturf. Ges. 22 (1898) 15. See *Helicarion helicoides* Semper.

MACROCHLAMYS HENRICI Semper. LUZON.

Man. Conchol. II 2 (1885) 104, pl. 35, figs. 19–21; ? *Macrochlamys henrici* SEMPER, Reisen Philippinen 3 (1870) 19, pl. 2, figs. 5*a–c*.

MACROCHLAMYS IMITATRIX Moellendorff. LEYTE; CEBU.

Lamprocystis imitatrix MOELLENDORFF, Senckenberg. Naturf. Ges. (1890) 207, pl. 7, fig. 9; (1893) 72.

MACROCHLAMYS KOCHI Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 201, pl. 7, fig. 6.

MACROCHLAMYS LACTEA Semper. PAMPANGA.

Man. Conchol. II 2 (1885) 118, pl. 39, figs. 98–100; *Microcystis lactea* SEMPER, Reisen Philippinen 3 (1870) 47, pl. 2, figs. 9*a–c*.

MACROCHLAMYS LATITANS Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. **26** (1894) 86.

MACROCHLAMYS LEUCOCHONDRIUM Moellendorff. TABLAS.

Lamprocystis leucochondrium MOELLENDORFF, Nachrichbl. Malak. Ges. **28** (1896) 5.

MACROCHLAMYS LEUCOCLIMAX Moellendorff. LUZON.

Lamprocystis leucoclimax MOELLENDORFF, Nachrichbl. Malak. Ges. **27** (1895) 112.

MACROCHLAMYS LEUCODISCUS Moellendorff. RIZAL; BULACAN.

Lamprocystis leucodiscus MOELLENDORFF, Nachrichbl. Malak. Ges. **26** (1894) 91.

MACROCHLAMYS LEUCOSPHAERION Quadras and Moellendorff. LUZON.

Lamprocystis leucosphaerion QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. **25** (1893) 172.

MACROCHLAMYS LUCIDELLA Pfeiffer. CAGAYAN.

Helix lucidella PFEIFFER, Proc. Zool. Soc. London (1846) 41; Conchol. Icon. **7** (1854) *Helix* pl. 37, fig. 164; Man. Conchol. II **2** (1885) 119, pl. 39, fig. 4.

MACROCHLAMYS MASBATICA Quadras and Moellendorff. MASBATE.

Lamprocystis masbatica QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. **27** (1895) 111.

MACROCHLAMYS MINDOROANA Quadras and Moellendorff. MINDORO.

Lamprocystis mindoroana QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. **26** (1894) 92.

MACROCHLAMYS MONTANA Quadras and Moellendorff. LUZON.

Lamprocystis montana QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. **27** (1895) 111.

MACROCHLAMYS MYOPS Dohrn and Semper. MINDANAO.

Man. Conchol. II **2** (1885) 121, pl. 40, figs. 53, 54; *Microcystis myops* DOHRN and SEMPER, Reisen Philippinen **3** (1870) 43, pl. 1, fig. 14; pl. 4, fig. 9; *Lamprocystis myops* DOHRN and SEMPER, Ann. & Mag. Nat. Hist. XIII **6** (1894) 51.

MACROCHLAMYS PERFORATA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. **26** (1894) 87.

MACROCHLAMYS PLANORBIS Moellendorff. CALAMIANES.

Lamprocystis planorbis MOELLENDORFF, Nachrichbl. Malak. Ges. **26** (1894) 101.

MACROCHLAMYS PLATYTAENIA Quadras and Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. **28** (1896) 83.

MACROCHLAMYS PSEUDOSUCCINEA Moellendorff. LEYTE; NEGROS; MINDANAO.

Lamprocystis pseudosuccinea MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 70.

MACROCHLAMYS PSEUSTES Smith. PALAWAN.

Ann. & Mag. Nat. Hist. XI **6** (1893) 348, pl. 18, figs. 1–3; Abh. Naturf. Ges. **22** (1898) 16.

MACROCHLAMYS PURPUREOFUSCA Quadras and Moellendorff. BATAAN.

Lamprocystis purpureofusca QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 27 (1895) 111.

MACROCHLAMYS RADIATA Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. 26 (1894) 87.

MACROCHLAMYS SANCHEZI Quadras and Moellendorff. DAPITAN; ZAMBOANGA.

Nachrichbl. Malak. Ges. 26 (1894) 87.

MACROCHLAMYS SARCODES Reeve. CAMARINES NORTE.

Helix sarcodes REEVE, Conchol. Icon. 7 (1854) *Helix* pl. 34, fig. 146; Man. Conchol. II 2 (1885) 105, pl. 35, fig. 32.

MACROCHLAMYS SEMIGLOBULUS Moellendorff. LUZON; LEYTE.

Lamprocystis semiglobulus MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 72.

MACROCHLAMYS SINICA Moellendorff. LUZON; MINDANAO.

Lamprocystis sinica MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 29.

MACROCHLAMYS SPECTABILIS Pfeiffer. SAMAR; LEYTE.

Helix spectabilis PFEIFFER, Proc. Zool. Soc. London (1845) 41; Conchol. Icon. 7 (1854) *Helix* pl. 34, figs. 148*a*, 148*b*; Man. Conchol. II 2 (1885) 107, pl. 36, figs. 62–65; *Macroceras spectabilis* PFEIFFER, Reisen Philippinen 3 (1870) 49, pl. 1, figs. 6, 7; pl. 4, figs. 4, 4*a*; pl. 6, fig. 25.

MACROCHLAMYS ST.-JOHNI Godwin Austen. PALAWAN.

Lamprocystis st.-johni GODWIN AUSTEN, Abh. Naturf. Ges. 22 (1898) 27.

MACROCHLAMYS SUBCARINATA Moellendorff. BULACAN.

Nachrichbl. Malak. Ges. 20 (1888) 20.

MACROCHLAMYS SUBCRYSTALLINA Moellendorff. LEYTE.

Lamprocystis subcrystallina MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 13, pl. 3, figs. 6–6*c*.

MACROCHLAMYS SUBFUSCA Beck. LAGUNA; SORSOGON.

Helix subfusca BECK, Proc. Zool. Soc. London (1848) 109; Conchol. Icon. 7 (1854) *Helix* pl. 189, fig. 1324; Man. Conchol. II 2 (1885) 105, pl. 35, figs. 33–35.

MACROCHLAMYS SUBGLOBULUS Moellendorff. SIQUIJOR; NEGROS.

Lamprocystis subglobulus MOELLENDORFF, Nachrichbl. Malak. Ges. 23 (1891) 4.

MACROCHLAMYS SUCCINEA Pfeiffer. LUZON; BOHOL; ZAMBOANGA.

Helix succinea PFEIFFER, Proc. Zool. Soc. London (1845) 39; Conchol. Icon. 7 (1854) *Helix* pl. 36, figs. 161*a*, 161*b*; Man. Conchol. II 2 (1885) 118, pl. 39, figs. 25–27; *Microcystis succinea* PFEIFFER, Reisen Philippinen 3 (1870) 44, pl. 3, fig. 11; pl. 6, fig. 22. See *Macrochlamys pseudosuccinea* Moellendorff.

MACROCHLAMYS VIRESCENS Quadras and Moellendorff. BUSUANGA.

Nachrichbl. Malak. Ges. 26 (1894) 86.

MACROCHLAMYS VITRINOIDES Deshayes. PHILIPPINES.

Helix vitrinoides DESHAYES, Conchol. Icon. 7 (1854) *Helix* pl. 34, fig. 151; *Nanina vitrinoides* DESHAYES, Obras Malacológicas (1890) 91.

Genus HEMITRICHIA Moellendorff

HEMITRICHIA BOETTGERI Moellendorff. SIBUYAN.

Nachrichbl. Malak. Ges. 22 (1890) 186.

HEMITRICHIA BRACHYTRICHA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 22 (1890) 182.

HEMITRICHIA CONSIMILIS Quadras and Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 26 (1894) 92.

HEMITRICHIA DEPRESSA Quadras and Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 26 (1894) 93.

HEMITRICHIA FLAVIDA Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 112.

HEMITRICHIA HIDALGOI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 20 (1888) 85; 22 (1890) 184.

HEMITRICHIA KOBELTI Moellendorff. SIBUYAN; ROMBLON.

Nachrichbl. Malak. Ges. 22 (1890) 186; Abh. Naturf. Ges. 22 (1898) 32.

HEMITRICHIA LACCATA Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 22 (1890) 177.

HEMITRICHIA LUTEOFASCIATA Lea. LUZON.

Abh. Naturf. Ges. 22 (1898) 29. See *Xesta luteofasciata* Lea.

HEMITRICHIA MOERCHI Pfeiffer. LUZON.

Abh. Naturf. Ges. 22 (1898) 32. See *Xesta morchii* Pfeiffer.

HEMITRICHIA OBLITA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 22 (1890) 178; Abh. Naturf. Ges. 22 (1898) 30; *Hemitrichia guimarasensis* THIELE, Nachrichbl. Malak. Ges. 27 (1895) 131.

HEMITRICHIA PLATENI Dohrn. PALAWAN.

Abh. Naturf. Ges. 22 (1898) 33.

HEMITRICHIA PLATYZONA Quadras and Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 28 (1896) 5.

HEMITRICHIA PRUINOSA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 22 (1890) 181.

HEMITRICHIA PURPURASCENS Moellendorff. ROMBLON; TABLAS.

Nachrichbl. Malak. Ges. 22 (1890) 179.

HEMITRICHIA SETIGERA Sowerby. LUZON; MARINDUQUE.

Abh. Naturf. Ges. 22 (1898) 33. See *Xesta setigera* Sowerby.

HEMITRICHIA SETOSULA Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 28 (1896) 6.

HEMITRICHIA STRIATULA Semper. LUZON.

Abh. Naturf. Ges. 22 (1898) 31. See *Rhysota striatula* Semper.

HEMITRICHIA TABLASENSIS Hidalgo. TABLAS.
Abh. Naturf. Ges. 22 (1898) 32.

HEMITRICHIA TAGALENSIS Dohrn. LUZON.
Abh. Naturf. Ges. 22 (1898) 32. See *Xesta tagalensis* Dohrn.

HEMITRICHIA VELUTINA Sowerby. QUIMARAS; NEGROS.
Abh. Naturf. Ges. 22 (1898) 31. See *Xesta velutina* Sowerby.

HEMITRICHIA VELUTINELLA Quadras and Moellendorff. MASBATE.
Nachrichbl. Malak. Ges. 27 (1895) 75.

Genus HEMIGLYPTA Moellendorff

HEMIGLYPTA BLAINVILLEANA Lea. LUBANG.
Abh. Naturf. Ges. 22 (1898) 33. See *Rhysota blainvilleana* Lea.

HEMIGLYPTA CONNECTENS Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 14; Abh. Naturf. Ges. 22 (1898) 34.

HEMIGLYPTA CUVIERIANA Lea. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 24; Abh. Naturf. Ges. 22 (1898) 37. See *Rhysota cuvieriana* Lea.

HEMIGLYPTA FRANCISCANORUM Quadras and Moellendorff. CAMARINES NORTE.
Nachrichbl. Malak. Ges. 28 (1896) 6.

HEMIGLYPTA GLOBOSA Semper. MINDANAO.
Nachrichbl. Malak. Ges. 25 (1893) 21; Abh. Naturf. Ges. 22 (1898) 37. See *Rhysota globosa* Semper.

HEMIGLYPTA INFRASTRIATA Moellendorff. MINDANAO.
Nachrichbl. Malak. Ges. 25 (1893) 22.

HEMIGLYPTA MAYONENSIS Hidalgo. ALBAY.
Nanina mayonensis HIDALGO, Obras Malacológicas (1890) 19, 79, No. 67; Abh. Naturf. Ges. 22 (1898) 36.

HEMIGLYPTA MICROGLYPTA Moellendorff. CATANDUANES.
Nachrichbl. Malak. Ges. 25 (1893); Abh. Naturf. Ges. 22 (1898) 37.

HEMIGLYPTA MOUSSONI Semper. LUZON.
Abh. Naturf. Ges. 22 (1898) 33. See *Rhysota blainvilleana* Lea.

HEMIGLYPTA PANAYENSIS Brod. PANAY.
Abh. Naturf. Ges. 22 (1898) 35. See *Rhysota panayensis* Brod.

HEMIGLYPTA SEMIGLOBOSA Pfeiffer. SAMAR; BOHOL; MINDANAO.
Senckenberg. Naturf. Ges. (1893) 73; Abh. Naturf. Ges. 22 (1898) 36. See *Rhysota semiglobosa* Pfeiffer.

HEMIGLYPTA SEMPERI Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 22 (1893) 11; Abh. Naturf. Ges. 22 (1898) 34.

HEMIGLYPTA WEBBII Bartsch. DAVAO.
Proc. Bio. Soc. Wash. 32 (1919) 15.

Genus BENSONIA Pfeiffer

BENSONIA ACUTIMARGO Pfeiffer. NEGROS.

Abh. Naturf. Ges. 22 (1898) 46. See *Trochomorpha acutimargo* Pfeiffer.

BENSONIA CARDIOSTOMA Quadras and Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 172.

BENSONIA CARINATA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 22 (1890) 200.

BENSONIA DIPLOTROPIS Quadras and Moellendorff. MASBATE.

Nachrichbl. Malak. Ges. 27 (1895) 75.

BENSONIA EUGLYPTA Quadras and Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 26 (1894) 94.

BENSONIA EURYOMPHALA Moellendorff. BENGUET.

Abh. Naturf. Ges. 22 (1898) 44.

BENSONIA EXASPERATA Moellendorff. RIZAL.

Nachrichbl. Malak. Ges. 26 (1894) 93.

BENSONIA HOLOTRACHIA Moellendorff. BENGUET.

Nachrichbl. Malak. Ges. 28 (1896) 85.

BENSONIA IGORROTICA Moellendorff. BENGUET.

Nachrichbl. Malak. Ges. 28 (1896) 85.

BENSONIA LIMA Moellendorff. LUZON; MARINDUQUE.

Nachrichbl. Malak. Ges. 22 (1890) 200.

BENSONIA LUZONICA Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 45. See *Eulota luzonica* Moellendorff.

BENSONIA QUADRASI Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 45. See *Eulota quadrasi* Moellendorff.

BENSONIA RADULA Pfeiffer. ILOCOS PROVINCE.

Helix radula PFEIFFER, Proc. Zool. Soc. London (1845) 40; Conchol. Icon. 7 (1854) *Helix* pl. 33, fig. 141; Abh. Naturf. Ges. 22 (1898) 45. See *Trochomorpha radula* Pfeiffer.

BENSONIA RADULELLA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 22 (1890) 199.

BENSONIA STRIGILIS Pfeiffer. NEGROS.

Abh. Naturf. Ges. 22 (1898) 46. See *Trochomorpha strigilis* Pfeiffer.

Genus TROCHOMORPHA Albers

TROCHOMORPHA ACUTIMARGO Pfeiffer. TABLAS; NEGROS; BOHOL.

Helix acutimargo PFEIFFER, Proc. Zool. Soc. London (1845) 40; Conchol. Icon. 7 (1854) *Helix* pl. 33, figs. 140*a*, 140*b*; Man. Conchol. II 3 (1885–7) 85, 267, pl. 17, figs. 25–27; 9 (1894) 4. See *Bensonia acutimargo* Pfeiffer.

TROCHOMORPHA ALBOCINCTA Pfeiffer. NEGROS.

Helix albocincta PFEIFFER, Proc. Zool. Soc. London (1845) 123; Man. Conchol. II 3 (1885–7) 86, 267, pl. 17, fig. 36; 9 (1894) 4.

TROCHOMORPHA ALTICOLA Moellendorff. RIZAL.

Man. Conchol. II 9 (1894) 337; Nachrichbl. Malak. Ges. 26 (1894) 102.

TROCHOMORPHA BAGOENSIS Hidalgo. NEGROS.

Obras Malacológicas (1890) 118; Man. Conchol. II 8 (1892) 134; 9 (1894) 4.

TROCHOMORPHA BECKIANA Pfeiffer. LUZON; MINDORO.

Helix beckiana PFEIFFER, Proc. Zool. Soc. London (1842) 87; Conchol. Icon. 7 (1854) *Helix* pl. 33, figs. 145*a*, 145*b*; Man. Conchol. II 3 (1885–7) 86, pl. 17, figs. 33–35; 9 (1894) 4; Obras Malacológicas (1890) 132, 189, pl. 20, figs. 1, 2.

TROCHOMORPHA BINTUANENSIS Hidalgo. BUSUANGA.

Obras Malacológicas (1890) 116; Man. Conchol. II 8 (1892) 134; 9 (1894) 4; Abh. Naturf. Ges. 22 (1898) 48.

TROCHOMORPHA BOETTGERI Moellendorff. TABLAS; ROMBLON.

Man. Conchol. II 8 (1892) 134; 9 (1894) 4; Abh. Naturf. Ges. 22 (1898) 53.

TROCHOMORPHA BOHOLENSIS Semper. BOHOL.

Reisen Philippinen 3 (1870) 116.

TROCHOMORPHA CEREA Moellendorff. SARANGANI ISLAND, MINDANAO.

Abh. Naturf. Ges. 22 (1898) 48.

TROCHOMORPHA CONOMPHALA Pfeiffer. PHILIPPINES.

Man. Conchol. II 3 (1885–7) 84, pl. 17, fig. 16; 9 (1894) 4, 337.

TROCHOMORPHA COSTELLIFERA Moellendorff. CEBU.

Man. Conchol. II 8 (1892) 125, pl. 20, figs. 8–10; 9 (1894) 4; Senckenberg. Naturf. Ges. (1890) 214, pl. 8, fig. 3; Obras Malacológicas (1890) 116.

TROCHOMORPHA CRASSULA Moellendorff. BULACAN.

Man. Conchol. II 9 (1894) 337; Abh. Naturf. Ges. 22 (1898) 52.

TROCHOMORPHA CROSSEI Hidalgo. BUSUANGA.

Obras Malacológicas (1890) 117; Man. Conchol. II 8 (1892) 134; 9 (1894) 4; Abh. Naturf. Ges. 22 (1898) 49.

TROCHOMORPHA CURVILABRUM Adams and Reeve. PHILIPPINES.

Helix curvilabrum ADAMS and REEVE, H. M. S. Samarang Voy. Zool. Publ. London (1850) 59, pl. 14, figs. 9*a*, 9*b*; Conchol. Icon. 7 (1854) *Helix* pl. 105, fig. 581, Man. Conchol. II 3 (1885–7) 86, 267, pl. 17, fig. 37; 9 (1894) 4.

TROCHOMORPHA DECIPIENS Quadras and Moellendorff. CAGAYAN.

Abh. Naturf. Ges. 22 (1898) 49.

TROCHOMORPHA GOULDII Pfeiffer. LUZON; NEGROS; BALABAC.

Man. Conchol. II 3 (1885–7) 77, pl. 14, fig. 24; 9 (1894) 4; *Helix gouldi* PFEIFFER, Proc. Zool. Soc. London (1845) 124; Conchol. Icon. 7 (1854) *Helix* pl. 36, fig. 163.

TROCHOMORPHA GRACILIS Moellendorff. CAGAYAN; ISABELA.

Man. Conchol. II **9** (1894) 337; Nachrichbl. Malak. Ges. **26** (1894) 103.

TROCHOMORPHA GRANULOSA Moellendorff. SIQUIJOR.

Obras Malacológicas (1890) 114; Man. Conchol. II **8** (1892) 125, pl. 20, figs. 20–24; **9** (1894) 4.

TROCHOMORPHA HEPTAGYRA Moellendorff. SURIGAO.

Man. Conchol. II **9** (1894) 337; Nachrichbl. Malak. Ges. **26** (1894) 104.

TROCHOMORPHA INFANDA Semper. ISABELA.

Man. Conchol. II **3** (1885–7) 86; **8** (1892) 120, pl. 20, fig. 4; **9** (1894) 4; Reisen Philippinen **3** (1870) 117.

TROCHOMORPHA INTERMEDIA Moellendorff. POLILLO.

Man. Conchol. II **9** (1894) 337; Nachrichbl. Malak. Ges. **26** (1894) 103.

TROCHOMORPHA KIERULFII Mörch. MARINDUQUE.

Helix kierulfi MÖRCH, Obras Malacológicas (1890) 132, 189, pl. 20, figs. 3, 4; Abh. Naturf. Ges. **22** (1898) 55.

TROCHOMORPHA LOOCENSIS Hidalgo. PALAWAN; TABLAS.

Obras Malacológicas (1893) 21; Man. Conchol. II **3** (1885–7) 267; **8** (1892) 120, pl. 20, figs. 11–13; **9** (1894) 4.

TROCHOMORPHA LUTEOBRUNNEA Moellendorff. SIBUYAN.

Man. Conchol. II **8** (1892) 120, pl. 20, figs. 20, 21; **9** (1894) 4.

TROCHOMORPHA METCALFEI Pfeiffer. LUZON; PALAWAN; CEBU; LEYTE.

Helix metcalfei PFEIFFER, Proc. Zool. Soc. London (1845) 66; Conchol. Icon. **7** (1854) *Helix* pls. 30, 35, figs. 127*a*–127*c*; Man. Conchol. II **3** (1885–7) 85, pl. 17, figs. 17–19, 22, 23; **8** (1892) 121; **9** (1894) 4; Ann. & Mag. Nat. Hist. XI **6** (1893) 349, (1894) 53.

TROCHOMORPHA MINDOROANA Quadras and Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. **27** (1895) 114.

TROCHOMORPHA MORONGENSIS Moellendorff. RIZAL.

Man. Conchol. II **9** (1894) 337; Nachrichbl. Malak. Ges. **26** (1894) 102.

TROCHOMORPHA NEGLECTA Pilsbry. MINDORO (?).

Man. Conchol. II **8** (1892) 124, pl. 20, figs. 14–16; **9** (1894) 4.

TROCHOMORPHA NITIDELLA Moellendorff. PANGASINAN.

Abh. Naturf. Ges. **22** (1898) 52.

TROCHOMORPHA PLANORBIS Lesson. SIQUIJOR; SURIGAO.

Abh. Naturf. Ges. **22** (1898) 51.

TROCHOMORPHA PLATYSMA Quadras and Moellendorff. BOHOL.

Nachrichbl. Malak. Ges. **28** (1896) 86.

TROCHOMORPHA PSEUDOSERICINA Boettger. PALAWAN.

Man. Conchol. II **9** (1894) 337; Abh. Naturf. Ges. **22** (1898) 50.

TROCHOMORPHA QUADRASI Hidalgo. NUEVA ECIJA.

Obras Malacológicas (1890) 117; Man. Conchol. II **8** (1892) 122; **9** (1894) 4, pl. 7, figs. 1–3.

TROCHOMORPHA RADULA Pfeiffer. LUZON.

Man. Conchol. II **3** (1885–7) 85, 267, pl. 17, figs. 28–30; **9** (1894) 4, 337. See *Bensonia radula* Pfeiffer.

TROCHOMORPHA REPANDA Moellendorff. PHILIPPINES.

Man. Conchol. II **8** (1892) 123; **3** (1885–7) pl. 17, figs. 20–21; **9** (1894) 4; Proc. Biol. Soc. Wash. 32 (1919) 16. See *Trochomorpha metcalfei* Pfeiffer.

TROCHOMORPHA RUFA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. **20** (1888) 144; Man. Conchol. II **8** (1892) 133; **9** (1894) 4.

TROCHOMORPHA SCHMACKERI Moellendorff. MINDORO.

Man. Conchol. II **9** (1894) 337; Nachrichbl. Malak. Ges. **26** (1894) 102.

TROCHOMORPHA SERICATA Moellendorff. CAGAYAN.

Abh. Naturf. Ges. **22** (1898) 49.

TROCHOMORPHA SERICINA Moellendorff. LEYTE.

Man. Conchol. II **9** (1894) 337; Senckenberg. Naturf. Ges. (1893) 74, pl. 3, figs. 7–7*c*.

TROCHOMORPHA SIBUYANICA Hidalgo. SIBUYAN.

Obras Malacológicas (1890) 20; Man. Conchol. II **3** (1885–7) 267; **8** (1892) 121, pl. 20, figs. 17–19; **9** (1894) 4.

TROCHOMORPHA SPLENDENS Semper. SIBUYAN; CEBU.

Man. Conchol. II **3** (1885–7) 86, 267; **8** (1892) 123, pl. 20, figs. 5–7; **9** (1894) 4; Reisen Philippinen **3** (1870) 118; Senckenberg. Naturf Ges. (1890) 213, pl. 8, fig. 1.

TROCHOMORPHA SPLENDIDULA Moellendorff. CEBU; LEYTE.

Man. Conchol. II **8** (1892) 123, pl. 20, figs. 1–3; **9** (1894) 4; Senckenberg. Naturf. Ges. (1890) 214, pl. 8, fig. 2.

TROCHOMORPHA STENOZONA Moellendorff. LUZON.

Man. Conchol. II **8** (1892) 133; **9** (1894) 4.

TROCHOMORPHA STRIGILIS Pfeiffer. NEGROS.

Helix strigilis PFEIFFER, Proc. Zool. Soc. London (1845) 124; Conchol. Icon. **7** (1854) *Helix* pl. 36, figs. 160*a*, 160*b*; Man. Conchol. II **3** (1885–7) 85, pl. 17, figs. 31, 32; **9** (1894) 4. See *Bensonia strigilis* Pfeiffer.

TROCHOMORPHA SUBTAENIATA Quadras and Moellendorff. BOHOL.

Nachrichbl. Malak. Ges. **28** (1896) 86.

TROCHOMORPHA SUTURALIS Moellendorff. SURIGAO.

Man. Conchol. II **9** (1894) 339; Nachrichbl. Malak. Ges. **26** (1894) 104.

TROCHOMORPHA SYNŒCIA Moellendorff. SIQUIJOR.

Man. Conchol. II **8** (1892) 133; **9** (1894) 5. See *Trochomorpha planorbis* Lesson.

Family ENDODONTIDÆ

Genus ENDODONTA Albers

ENDODONTA PHILIPPINENSIS Semper. RIZAL; CEBU; MINDANAO.

Man. Conchol. II **9** (1894) 27; **3** (1885–7) 62; **8** (1892) 82, pl. 37, figs. 38–40; **9** (1894) 27; Reisen Philippinen **3** (1870) 140.

Genus PYRAMIDULA Fitzinger

PYRAMIDULA APERTA Moellendorff. MONTALBAN; RIZAL; BUSUANGA; LEYTE.

Man. Conchol. II **8** (1892) 80, pl. 37, figs. 35–37; **9** (1894) 47; *Patula aperta* MOELLENDORFF, Abh. Naturf. Ges. **22** (1898) 63.

Family HELICIDÆ

Genus OBBA Beck

OBBA BASIDENTATA Pfeiffer. EAST COAST OF MINDANAO; BOHOL.

Helix basidentata PFEIFFER, Proc. Zool. Soc. London (1856) 329; Obras Malacológicas (1890) 123, 181, pl. 15, fig. 12; pl. 131, fig. 3; Man. Conchol. II **6** (1890) 223; *Obbina basidentata* PFEIFFER, Reisen Philippinen **3** (1870) 124.

OBBA BIGONIA Férussac. SAMAR; LEYTE; EASTERN MINDANAO; BASILAN.

Helix bigonia FÉRUSSAC, Conchol. Icon. **7** (1854) *Helix* pl. 24, fig. 105; Obras Malacológicas (1890) 121, 180, pl. 15, figs. 1–3; Man. Conchol. II **6** (1890) 226, pl. 55, figs. 45–47; *Helix samarensis* PFEIFFER, Proc. Zool. Soc. London (1842) 87.

OBBA BULACANENSIS Hidalgo. BULACAN.

Helix bulacanensis HIDALGO, Obras Malacológicas (1890) 48, 131, 189, pl. 17, figs. 6, 7; Man. Conchol. II **6** (1890) 226, pl. 65, figs. 78, 79.

OBBA BUSTOI Hidalgo. TABLAS.

Helix bustoi HIDALGO, Obras Malacológicas (1890) 22, 131, 188, pl. 17, figs. 1–3; Man. Conchol. II **6** (1890) 230, pl. 60, figs. 13, 14.

OBBA CAMELUS Pfeiffer. CALAMIANES.

Helix camelus PFEIFFER, Obras Malacológicas (1890) 179, pl. 136, figs. 6, 7.

OBBA CODONODES Pfeiffer. PHILIPPINES.

Helix codonodes PFEIFFER, Proc. Zool. Soc. London (1846) 112.

OBBA COLUMBARIA Sowerby. LAGUNA; ALBAY.

Helix columbaria SOWERBY, Proc. Zool. Soc. London (1841) 19; Conchol. Icon. **7** (1854) *Helix* pl. 14, figs. 54*a*, 54*b*; Man. Conchol. II **6** (1890) 234, pl. 54, figs. 14–17; Obras Malacológicas (1890) 123, 181, pl. 18, figs. 4–9.

OBBA FLAVOPICTA Quadras and Moellendorff. BENGUET.

Helix flavopicta QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 182, pl. 143, figs. 4, 5; *Obbina flavopicta* QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 95.

OBBA GALLINULA Pfeiffer. LUZON; CEBU.

Helix gallinula PFEIFFER, Proc. Zool. Soc. London (1845) 140; Conchol. Icon. 7 (1854) *Helix* pl. 30, figs. 130*a*, 130*b*; Man. Conchol. II 6 (1890) 219, pl. 57, figs. 88–90; 8 (1892) 270; Obras Malacológicas (1890) 126, 184, pl. 14, figs. 1–3; pl. 135, figs. 5, 6.

OBRA HEMIODON Moellendorff. GUIMARAS; NEGROS; MASBATE.

Obbina hemiodon MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 59.

OBBA HORIZONTALIS Pfeiffer. TABLAS; CEBU.

Helix horizontalis PFEIFFER, Proc. Zool. Soc. London (1845) 40; Conchol. Icon. 7 (1854) *Helix* pl. 27, figs. 116*a*, 116*b*; Man. Conchol. II 6 (1890) 232, pl. 57, figs. 97–100, 1; Obras Malacológicas (1890) 128, 185, pl. 15, figs. 4–7; pl. 137, fig. 6.

OBBA KOCHIANA Moellendorff. NORTHERN CEBU.

Man. Conchol. II 6 (1890) 231, pl. 59, figs. 43–45; Senckenberg. Naturf. Ges. (1890) 219, pl. 7, fig. 10; *Helix kochiana* MOELLENDORFF, Obras Malacológicas (1890) 129, 187, pl. 13, figs. 1–3.

OBBA LASALLII Eydoux. LUZON.

Helix lasallii EYDOUX, Conchol. Icon. 7 (1854) *Helix* pl. 28, figs. 121*a*, 121*b*; Obras Malacológicas (1890) 127, 184, pl. 13, figs. 4–7; Man. Conchol. II 6 (1890) 233, pl. 54, figs. 20–22; *Helix meretrix* SOWERBY, Proc. Zool. Soc. London (1841) 20.

OBBA LISTERI Gray. CAMIGUIN DE LUZON; SOUTHERN LUZON; VISAYAN ISLANDS.

Helix listeri GRAY, Proc. Zool. Soc. London (1840) 37; Man. Conchol. II 6 (1890) 218, pl. 56, figs. 59–66; *Obbina listeri* GRAY, Reisen Philippinen 3 (1870) 125; Abh. Naturf. Ges. 22 (1898) 61; Obras Malacológicas (1890) 125, 183, pl. 14, figs. 7–12.

OBBA LIVESAYI Pfeiffer. CEBU; MACTAN; BOHOL; CAMOTES.

Helix livesayi PFEIFFER, Proc. Zool. Soc. London (1860) 134; Obras Malacológicas (1890) 129, 187, pl. 16, figs. 1–4; pl. 137, figs. 7, 8; Man. Conchol. II 6 (1890) 223, pl. 56, figs. 72, 73; pl. 59, figs. 46, 47.

OBBA MARGINATA Müller. LEYTE; MINDANAO.

Helix marginata MÜLLER, Conchol. Icon. 7 (1854) *Helix* pl. 30, figs. 129*a*, 129*b*; Obras Malacológicas (1890) 129, 186, pl. 16, figs. 5–7; Man. Conchol. II 6 (1890) 227, pl. 57, figs. 4–6; Ann. & Mag. Nat. Hist. XIII 6 (1894) 54. Journ. Wash. Acad. Sci. 8 (1918) 60–63; *Obbina marginata* MÜLLER, Reisen Philippinen 3 (1870) 127.

OBBA MORICANDI Sowerby. ISLETS OF NORTHERN AND EASTERN MINDANAO; BOHOL; LAGUNA.

Helix moricandi SOWERBY, Proc. Zool. Soc. London (1842) 86; Conchol. Icon. 7 (1854) *Helix* pl. 15, fig. 58; Obras Malacológicas (1890) 122, 181, pl. 15, figs. 8–11; Man. Conchol. II 6 (1890) 222, pl. 54, figs. 24–27; *Obbina moricandi* SOWERBY, Reisen Philippinen 3 (1870) 123.

OBBA MORONGENSIS Moellendorff. LUZON.

Obbina morongensis MOELLENDORFF, Abh. Naturf. Ges. 22 (1898) 57.

OBBA PARMULA Broderip. NEGROS; CEBU.

Helix parmula BRODERIP, Proc. Zool. Soc. London (1840) 38; Conchol. Icon. 7 (1854) *Helix* pl. 28, figs. 120*a*, 120*b*; Obras Malacológicas (1890) 131, 188, pl. 17, figs. 8–10; pl. 138, figs. 6–9; Man. Conchol. II 6 (1890) 229, pl. 57, figs. 85–87; pl. 65, figs. 73–75; *Helix conomphala* PFEIFFER, Conchol. Icon. 7 (1854) *Helix* pl. 156, fig. 1019; Proc. Zool. Soc. London (1853) 59.

OBBA PLANULATA Lamarck. LUZON; MINDORO; MARINDUQUE.

Helix planulata LAMARCK, Conchol. Icon. 7 (1854) *Helix* pl. 28, figs. 122*a*–122*d*; Obras Malacológicas (1890) 124, 182, pl. 14, figs. 1–6; Man. Conchol. II 6 (1890) 220, pl. 55, figs. 51–54; *Obbina planulata* LAMARCK, Reisen Philippinen 3 (1870) 121, pl. 8, fig. 9; pl. 12, figs. 4–6; pl. 18, fig. 1; Abh. Naturf. Ges. 22 (1898) 59.

OBBA PLATYZONA Moellendorff. CAMOTES.

Obbina platyzona MOELLENDORFF, Nachrichbl. Malak. Ges. 22 (1890) 203; *Helix platyzona* MOELLENDORFF, Obras Malacológicas (1890) 181, pl. 137, figs. 3, 4.

OBBA REEVEANA Pfeiffer. CEBU.

Helix reeveana PFEIFFER, Obras Malacológicas (1890) 128, 186, pl. 138, figs. 1–5; Man. Conchol. II 6 (1890) 233, pl. 55, figs. 31–36.

OBBA ROTA Broderip. CAMOTES ISLANDS; SIQUIJOR; BOHOL; BASILAN.

Helix rota BRODERIP, Proc. Zool. Soc. London (1841) 45; Conchol. Icon. 7 (1854) *Helix* pls. 30, 35, figs. 128*a*, 128*b*; Obras Malacológicas (1890) 130, 188, pl. 16, figs. 8–12; Man. Conchol. II 6 (1890) 225, pl. 56, figs. 77–79; Journ. Wash. Acad. Sci. 8 (1918) 16; *Obbina rota* BRODERIP, Reisen Philippinen 3 (1870) 122.

OBBA SARANGANICA Hidalgo. SARANGANI.

Helix saranganica HIDALGO, Obras Malacológicas (1890) 23, 129, 186, pl. 17, figs. 4, 5; pl. 137, fig. 5; Man. Conchol. II 6 (1890) 231, pl. 60, figs. 10, 11.

OBBA SCROBICULATA Pfeiffer. CEBU; BOHOL; LEYTE.

Helix scrobiculata PFEIFFER, Proc. Zool. Soc. London (1842) 88; Conchol. Icon. 7 (1854) *Helix* pl. 30, fig. 131; Obras Malacológicas (1890) 130, 187, pl. 13, figs. 8, 9; Man. Conchol. II 6 (1890) 224, pl. 56, figs. 67–71; Journ. Wash. Acad. Sci. 8 (1918) 17.

OBBA SUBHORIZONTALIS Moellendorff. SIBUYAN.

Obbina subhorizontalis MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 94.

OBBA VIRIDIFLAVA Moellendorff. NUEVA ECIJA.

Obbina viridiflava MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 94.

OBBA WORCESTERI Bartsch. OLANIVAN ISLAND, SARANGANI GROUP.

Proc. U. S. Nat. Mus. 45 (1913) 549, pl. 43, figs. 1–3.

Genus CAMÆNA Albers

CAMÆNA ADUSTA Sowerby. MINDORO.

Helix adusta SOWERBY, Proc. Zool. Soc. London (1840) 89; Conchol. Icon. 7 (1854) *Helix* pl. 19, fig. 77; Obras Malacológicas (1890) 176, pl. 93, fig. 2; Man. Conchol. II **8** (1892) 268, pl. 18, figs. 8, 9; **9** (1894) 104.

CAMÆNA ARATA Sowerby. TABLAS.

Helix arata SOWERBY, Proc. Zool. Soc. London (1840) 89; Conchol. Icon. 7 (1854) *Helix* pl. 15, figs. 59*a*–59*c*; Obras Malacológicas (1890) 174, pl. 89, figs. 1–4; Man. Conchol. II **8** (1892) 267, pl. 18, figs. 2–5; **9** (1894) 104.

CAMÆNA AVUS Pfeiffer. PHILIPPINES.

Helix avus PFEIFFER, Proc. Zool. Soc. London (1852) 83; Conchol. Icon. 7 (1854) *Helix* pl. 114, fig. 658; Obras Malacológicas (1890) 140, 196, pl. 133, figs. 4, 5; Man. Conchol. II **6** (1890) 210, pl. 27, figs. 15–17.

CAMÆNA BATANICA Adams and Reeve. BATAN, BASHEE GROUP.

Man. Conchol. II **6** (1890) 111, pl. 27, figs. 11, 12. See *Eulota batanica* Adams and Reeve.

CAMÆNA BINTUANENSIS Hidalgo. BUSUANGA.

Helix bintuanensis HIDALGO, Obras Malacológicas (1890) 51, 121, 178, pl. 12, fig. 4; pl. 131, fig. 2; Man. Conchol. II **6** (1890) 237, pl. 61, fig. 28; **9** (1894) 104.

CAMÆNA BRACHYODON Sowerby. MINDORO.

Helix brachyodon SOWERBY, Proc. Zool. Soc. London (1840) 89; Conchol. Icon. 7 (1854) *Helix* pl. 19, fig. 79; Obras Malacológicas (1890) 173, pl. 89, fig. 8; Man. Conchol. II **8** (1892) 267, pl. 18, fig. 1; **9** (1894) 104; *Helix mansalayensis* HIDALGO, Obras Malacológicas (1890) 172, pl. 89, figs. 6, 7.

CAMÆNA CALIGINOSA Adams and Reeve. MINDANAO.

Helix caliginosa ADAMS and REEVE, H. M. S. Samarang Voy. Zool. Publ. London (1850) 62, pl. 16, fig. 6; Obras Malacológicas (1890) 141, 197, pl. 144, figs. 3, 4; Man. Conchol. II **6** (1890) 123, pl. 27, figs. 9, 10, 10*a*.

CAMÆNA CAMPANULA Pfeiffer. CALAMIANES.

Helix campanula PFEIFFER, Obras Malacológicas (1890) 179, pl. 136, figs. 4, 5; Abh. Naturf. Ges. 22 (1898) 68; *Helix pollex* MOELLENDORFF, Obras Malacológicas (1890) 179, pl. 12, fig. 5.

CAMÆNA CERES Pfeiffer. PHILIPPINES.

Helix ceres PFEIFFER, Proc. Zool. Soc. London (1853) 49; Conchol. Icon. 7 (1854) *Helix* pl. 156, fig. 1021; Obras Malacológicas (1890) 121, 180, pl. 156, fig. 1; Man. Conchol. II **6** (1890) 239, pl. 53, fig. 69; **9** (1894) 104.

CAMÆNA LAGUNAE Hidalgo. LAGUNA; BALABAC.

Helix lagunae HIDALGO, Obras Malacológicas (1890) 23, 138, 195, pl. 19, fig. 6; Abh. Naturf. Ges. 22 (1898) 66.

CAMÆNA MONOCHROA Sowerby. TABLAS; PALAWAN.

Helix monochroa SOWERBY, Proc. Zool. Soc. London (1841) 1; Conchol. Icon. 7 (1854) *Helix* pl. 3, fig. 11; Obras Malacológicas (1890) 137, 194, pl. 19, figs. 3–5; pl. 12, fig. 1; Man. Conchol. II 6 (1890) 208, pl. 22, figs. 58–62.

CAMÆNA NAUJANICA Hidalgo. MINDORO.

Obras Malacológicas (1890) 33, 170, pl. 89, fig. 5; Abh. Naturf. Ges. 22 (1898) 70. See *Camæna brachyodon* Sowerby.

CAMÆNA OBLONGA Sowerby. LUBANG.

Helix oblonga SOWERBY, Proc. Zool. Soc. London (1841) 40; Conchol. Icon. 7 (1854) *Helix* pl. 23, fig. 99; Obras Malacológicas (1890) 177, pl. 91, fig. 8; Man. Conchol. II 8 (1892) 269, pl. 18, figs. 10–12; 9 (1894) 104.

CAMÆNA OOMORPHA Sowerby. TABLAS.

Helix oomorpha SOWERBY, Proc. Zool. Soc. London (1840) 103; Conchol. Icon. 7 (1854) *Helix* pl. 23, figs. 98*a*, 98*b*; Obras Malacológicas (1890) 177, pl. 91, figs. 6, 7; pl. 117, fig. 1; Man. Conchol. II 8 (1892) 269, pl. 6, figs. 29, 30; 9 (1894) 104.

CAMÆNA PALAWANICA Pfeiffer. PALAWAN.

Abh. Naturf. Ges. 22 (1898) 65.

CAMÆNA PALUMBA Souverbie. BUSUANGA.

Man. Conchol. II 6 (1890) 209, pl. 27, figs. 18, 19; pl. 41, figs. 12, 13, 14, 15; *Helix palumba* SOUVERBIE, Obras Malacológicas (1890) 138, 196, pl. 156, figs. 3, 4; pl. 19, fig. 2.

CAMÆNA PHILIPPINENSIS Semper. TABLAS.

Man. Conchol. II 6 (1890) 123, pl. 60, figs. 1, 2, 3, 4; *Helix philippinensis* SEMPER, Obras Malacológicas (1890) 140, 196, pl. 19, fig. 1.

CAMÆNA STOLIDOTA Quadras and Moellendorff. PALAWAN.

Helix stolidota QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 195, pl. 139, fig. 8; Man. Conchol. II 9 (1894) 342; Nachrichbl. Malak. Ges. 26 (1894) 105.

CAMÆNA SAULIAE Pfeiffer. PALAWAN.

Abh. Naturf. Ges. 22 (1898) 68.

CAMÆNA TRAILLI Pfeiffer. PALAWAN.

Helix trailli PFEIFFER, Proc. Zool. Soc. London (1855) 107; Obras Malacológicas (1890) 136, 194, pl. 136, fig. 3; Ann. & Mag. Nat. Hist. XI 6 (1893) 350; Man. Conchol. II 6 (1890) 207, pl. 23, figs. 63, 64; *Cochlostyla trailli* PFEIFFER, Obras Malacológicas (1890) 421, pl. 116, fig. 4; Proc. Biol. Soc. Wash. 31 (1918) 199, 200.

Genus CHLORITIS Beck

CHLORITIS BREVIDENS Sowerby. MINDORO.

Helix brevidens SOWERBY, Proc. Zool. Soc. London (1841) 25; Conchol. Icon. 7 (1854) *Helix* pl. 33, figs. 144*a*, 144*b;* Obras Malacológicas (1890) 134, 192, pl. 24, fig. 5; pl. 134, figs. 4–5; Man. Conchol. II 6 (1890) 272, pl. 55, figs. 37–41.

CHLORITIS DISCORDIALIS Férussac. MISAMIS (?).

Helix discordialis FÉRUSSAC, Obras Malacológicas (1890) 133, 190.

CHLORITIS EUPHROSYNE Smith. PALAWAN.

Helix euphrosyne SMITH, Obras Malacológicas (1890) pl. 158, fig. 3.

CHLORITIS FULTONI Moellendorff. MINDORO.

Abh. Naturf. Ges. 22 (1898) 70.

CHLORITIS INQUIETA Dohrn. PALAWAN.

Man. Conchol. II 8 (1892) 273; 9 (1894) 124.

CHLORITIS LEYTENSIS Moellendorff. LEYTE.

Man. Conchol. II 9 (1894) 124; Senckenberg. Naturf. Ges. (1893) 80, pl. 3, figs. 8–8*b*.

CHLORITIS MALBATENSIS Hidalgo. PHILIPPINES.

Helix malbatensis HIDALGO, Obras Malacológicas (1890) 132, 189, pl. 20, fig. 10; Man. Conchol. II 9 (1894) 124.

CHLORITIS QUIETA Reeve. MISAMIS.

Helix quieta REEVE, Conchol. Icon. 7 (1854) *Helix* pl. 33, figs. 142*a*, 142*b;* Obras Malacológicas (1890) 134, 191, pl. 20, fig. 11; Man. Conchol. II 6 (1890) 271, pl. 50, figs. 42, 43.

CHLORITIS SIBUTUENSIS Smith. SULU ARCHIPELAGO.

Ann. & Mag. Nat. Hist. XIII 6 (1894) 53, pl. 4, figs. 4, 4*a*.

CHLORITIS SUBSULCATA Moellendorff. CULION.

Nachrichbl. Malak. Ges. 26 (1894) 95; *Helix subsulcata* MOELLENDORFF, Obras Malacológicas (1890) 190, 272, pl. 134, figs. 1–3.

Genus PAPUINA Martens

PAPUINA LABIUM Férussac. MINDANAO.

Helix labium FÉRUSSAC, Conchol. Icon. 7 (1854) *Helix* pl. 22, figs. 92*a*, 92*b*.

PAPUINA PENNANTIANA Pfeiffer. PHILIPPINES.

Helix pennantiana PFEIFFER, Proc. Zool. Soc. London (1845) 67.

PAPUINA PLURIZONATA Adams and Reeve. MINDANAO.

Helix plurizonata ADAMS and REEVE, H. M. S. Samarang Voy. Zool. Publ. London (1850) 62, pl. 16, fig. 9; Conchol. Icon. 7 (1854) *Helix* pl. 96, fig. 528.

PAPUINA PSEUDOLABIUM Pfeiffer. MINDANAO (?). PAPUAN SPECIES.

Man. Conchol. II 7 (1891) 38, pl. 12, figs. 20, 21.

Genus PLECTOPYLIS Benson

PLECTOPYLIS COARCTATA Moellendorff. BOHOL.

Nachrichbl. Malak. Ges. **26** (1894) 104; *Brazieria coarctata* MOELLENDORFF, Abh. Naturf. Ges. **22** (1898) 123; *Helix coarctata* MOELLENDORFF, Obras Malacológicas (1890) 167, pl. 157, figs. 18, 19.

PLECTOPYLIS POLYPTYCHIA Moellendorff. CEBU; SIQUIJOR.

Abh. Naturf. Ges. 22 (1898) 122.

PLECTOPYLIS QUADRASI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. **25** (1893) 172; Abh. Naturf. Ges. **22** (1898) 123; *Helix quadrasi* MOELLENDORFF, Obras Malacológicas (1890) 167, pl. 156, figs. 9, 10.

PLECTOPYLIS TROCHOSPIRA Moellendorff. CEBU.

Helix trochospira MOELLENDORFF, Obras Malacológicas (1890) 118, 167, pl. 156, figs. 7, 8; Abh. Naturf. Ges. **22** (1898) 123.

Genus GANESELLA Blanford

GANESELLA APEX Quadras and Moellendorff. CALAMIANES.

Helix apex QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 198, pl. 145, fig. 11; Nachrichbl. Malak. Ges. **28** (1896) 7.

GANESELLA CATOCYRTA Quadras and Moellendorff. CALAMIANES.

Helix catocyrta QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 198, pl. 145, fig. 8; *Satsuma catocyrta* QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. **27** (1895) 115; Abh. Naturf. Ges. **22** (1898) 71.

GANESELLA FERNANDEZI Hidalgo. BUSUANGA.

Helix fernandezi HIDALGO, Obras Malacológicas (1890) 52, 142, 197, pl. 145, figs. 4, 5; Man. Conchol. II **8** (1892) 202, pl. 53, figs. 68, 69; **9** (1894) 170.

GANESELLA GOULDI Pfeiffer. LUZON; NEGROS.

Satsuma gouldi PFEIFFER, Abh. Naturf. Ges. **22** (1898) 71.

GANESELLA LARGILLIERTI Philippi. PHILIPPINES.

Helix largillierti PHILIPPI, Obras Malacológicas (1890) 118, 168; *Helix immaculata* ADAMS and REEVE, H. M. S. Samarang Voy. Zool. Publ. London (1850) **62**, pl. 16, fig. 5; Conchol. Icon. **7** (1854) *Helix* pl. 79, fig. 420.

GANESELLA PALANANICA Quadras and Moellendorff. ISABELA.

Helix palananica QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 170, pl. 157, figs. 16, 17; Nachrichbl. Malak. Ges. **28** (1896) 7.

GANESELLA PLANASI Hidalgo. BUSUANGA.

Helix planasi HIDALGO, Obras Malacológicas (1890) 52, 142, 197, pl. 145, fig. 10; Man. Conchol. II **8** (1892) 202, pl. 53, figs. 73, 74; **9** (1894) 170.

GANESELLA POECILOTROCHUS Moellendorff. PHILIPPINES.

Helix poecilotrochus MOELLENDORFF, Obras Malacológicas (1890) 198, pl. 145, fig. 9; Man. Conchol. II **9** (1894) 170; Nachrichbl. Malak. Ges. **26** (1894) 105.

GANESELLA STENODESMA Quadras and Moellendorff. CALAMIANES.

Helix stenodesma QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 198, pl. 145, fig. 7; Nachrichbl. Malak. Ges. **28** (1896) 86.

GANESELLA TROCHOMORPHA Moellendorff. CEBU; SIQUIJOR; LEYTE.

Man. Conchol. II **8** (1892) 202, pl. 53, figs. 82, 83; **9** (1894) 170. See *Omphalotropis trochomorpha* MOELLENDORFF.

GANESELLA TROCHUS Moellendorff. CEBU.

Helix trochus MOELLENDORFF, Obras Malacológicas (1890) 142, 197, pl. 156, figs. 11, 12; Man. Conchol. II **8** (1892) 201, pl. 53, figs. 84, 85; **9** (1894) 170.

Genus EULOTA Hartmann

EULOTA BATANICA Adams and Reeve. BATANES.

Helix batanica ADAMS and REEVE, H. M. S. Samarang Voy. Zool. Publ. London (1850) 60, pl. 15, figs. 5*a*, *b*; Conchol. Icon. **7** (1854) *Helix* pl. 105, fig. 588; Obras Malacológicas (1890) 136, 194, pl. 24, fig. 6; Abh. Naturf. Ges. **22** (1898) 72. See *Camæna batanica* Adams and Reeve.

EULOTA CARINIFERA Semper. LUZON.

Helix carinifera SEMPER, Obras Malacológicas (1890) 136, 193, pl. 156, fig. 2; Man. Conchol. II **8** (1892) 220, pl. 51, figs. 29, 30; **9** (1894) 204; *Chloræa carinifera* SEMPER, Reisen Philippinen **3** (1870) 233, pl. 10, fig. 1.

EULOTA DISSIMILIS Semper. CAGAYAN.

Helix dissimilis SEMPER, Obras Malacológicas (1890) 136, 193, pl. 145, fig. 6; Man. Conchol. II **8** (1892) 220, pl. 51, figs. 42, 43; **9** (1894) 204; *Chloræa dissimilis* SEMPER, Reisen Philippinen **3** (1870) 233, pl. 10, fig. 8.

EULOTA FODIENS Pfeiffer. LUZON; SIQUIJOR; LEYTE.

Helix fodiens PFEIFFER, Proc. Zool. Soc. London (1845) 39; Conchol. Icon. **7** (1854) *Helix* pl. 24, fig. 106; Obras Malacológicas (1890) 135, 193, pl. 20, figs. 7, 8; Man. Conchol. II **3** (1885–7) 212, pl. 49, figs. 8, 9; **9** (1894) 204; *Chloræa fodiens* PFEIFFER, Reisen Philippinen **3** (1870) 232, pl. 14, figs. 3*a*, *b*.

EULOTA LUZONICA Moellendorff. RIZAL.

Man. Conchol. II **9** (1894) 344; *Plectotropis luzonica* MOELLENDORFF, Nachrichbl. Malak. Ges. **26** (1894) 105. See *Bensonia luzonica* Moellendorff.

EULOTA MIGHELSIANA Pfeiffer. SURIGAO.

Helix mighelsiana PFEIFFER, Proc. Zool. Soc. London (1846) 110; Conchol. Icon. **7** (1854) *Helix* pl. 33, fig. 143; Obras Malacológicas (1890) 134, 193, pl. 143, fig. 6; Man. Conchol. II **3** (1885–7) 212, pl. 49, figs. 6, 7; **9** (1894) 204; *Chloræa mighelsiana* PFEIFFER, Reisen Philippinen **3** (1870) 232, pl. 10, fig. 3.

EULOTA QUADRASI Moellendorff. ISABELA.

Plectotropis quadrasi MOELLENDORFF, Nachrichbl. Malak. Ges. **28** (1896) 8. See *Bensonia quadrasi* Moellendorff.

EULOTA SANZIANA Hombron and Jacquinot. ZAMBOANGA.

Helix sanziana HOMBRON and JACQUINOT, Voy. Astralabe and Zélee (1854) 9, pl. 4, figs. 19–23; Obras Malacológicas (1890) 141, 197, pl. 20, fig. 6; Man. Conchol. II **6** (1890) 272, pl. 37, figs. 51–54; **9** (1894) 212; *Chloritis sanziana* HOMBRON and JACQUINOT, Reisen Philippinen **3** (1870) 235.

EULOTA SCHADENBERGI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. **20** (1888) 144; *Helix schadenbergi* MOELLENDORFF, Obras Malacológicas (1890) 136, 194, pl. 143, fig. 11.

EULOTA SIMILARIS Férussac. NEAR MANILA.

Helix similaris FÉRUSSAC, Conchol. Icon. **7** (1854) *Helix* pl. 34, figs. 149*a*, 149*b*; Obras Malacológicas (1890) 119, 168, pl. 20, fig. 5; Abh. Naturf. Ges. **22** (1898) 72.

EULOTA SPINOSISSIMA Semper. MINDANAO.

Helix spinosissima SEMPER, Obras Malacológicas (1890) 141, 197, pl. 20, fig. 9; Man. Conchol. II **6** (1890) 273, pl. 37, figs. 55, 56; **9** (1894) 212; *Chloritis spinosissima* SEMPER, Reisen Philippinen **3** (1870) 234, pl. 9, figs. 10*a*, *b*; pl. 14, figs. 9*a*, *b*; *Helix boxallii* SOWERBY, Proc. Zool. Soc. London (1888) 211.

EULOTA VISAYANA Moellendorff. LEYTE; BOHOL; GUIMARAS.

Helix visayana MOELLENDORFF, Obras Malacológicas (1890) 120, 170, pl. 157, figs. 12, 13; Man. Conchol, II **9** (1894) 209; *Plectotropis visayana* MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 79.

EULOTA WINTERIANA Pfeiffer. GUIMARAS.

Helix winteriana PFEIFFER, Conchol. Icon. **7** (1854) *Helix* pl. 36, fig. 162.

Genus CHLORÆA Albers

CHLORÆA ALMAE Moellendorff. CEBU.

Abh. Naturf. Ges. **22** (1898) 76.

CHLORÆA AMŒNA Pfeiffer. LUZON.

Helix amoena PFEIFFER, Proc. Zool. Soc. London (1845) 65; Obras Malacológicas (1890) 162, 213, pl. 27, figs. 11, 12; Man. Conchol. II **7** (1891) 98, pl. 21, figs. 21, 22; **9** (1894) 215.

CHLORÆA ANTONII Semper. NORTHWESTERN LUZON.

Man. Conchol. II **7** (1891) 97, pl. 21, figs. 34, 35; Reisen Philippinen **3** (1870) 228, pl. 10, figs. 10*a*, *b*.

CHLORÆA BENGUETENSIS Semper. BENGUET.

Helix benguetensis SEMPER, Obras Malacológicas (1890) 158, 212, pl. 25, figs. 1–3; Man. Conchol. II **7** (1891) 96, pl. 21, figs. 23–35; **9** (1894) 215; Reisen Philippinen **3** (1870) 227, pl. 8, fig. 11, 12; pl. 14, figs. 5–8.

CHLORÆA BIFASCIATA Lea. LUZON.

Abh. Naturf. Ges. **22** (1898) 73.

CHLORÆA COERULEA Moellendorff. RIZAL; BULACAN.

Helix coerulea MOELLENDORFF, Obras Malacológicas (1890) 154, 210, pl. 27, figs. 1, 2; Man. Conchol. II 7 (1891) 101; 9 (1894) 215.

CHLORÆA CONSTRICTA Pfeiffer. MINDORO.

Helix constricta PFEIFFER, Proc. Zool. Soc. London (1845) 39; Conchol. Icon. 7 (1854) *Helix* pl. 203, fig. 1432; Man. Conchol. II 7 (1891) 103, pl. 22, figs. 16, 17; 9 (1894) 215; *Helix restricta* PFEIFFER, Obras Malacológicas (1890) 162, 213, pl. 135, figs. 3, 4.

CHLORÆA CRISTATELLA Moellendorff. PHILIPPINES.

Helix cristatella MOELLENDORFF, Obras Malacológicas (1890) 209, pl. 144, figs. 5, 6; Man. Conchol. II 9 (1894) 215.

CHLORÆA DRYOPE Broderip. LUZON; BURIAS; TABLAS; SIBUYAN.

Helix dryope BRODERIP, Proc. Zool. Soc. London (1840) 37; Conchol. Icon. 7 (1854) *Helix* pl. 29, figs. 124*a*–124*d;* Obras Malacológicas (1890) 154, 210, pl. 102, figs. 1–8; Man. Conchol. II 7 (1891) 100, pl. 22, figs. 1–7; 9 (1894) 215.

CHLORÆA ELISABETHAE Semper. CALAYAN ISLAND, BABUYANES.

Abh. Naturf. Ges. 22 (1898) 77.

CHLORÆA FIBULA Broderip. LUZON; LUBANG; MARINDUQUE; CEBU.

Helix fibula BRODERIP, Conchol. Icon. 7 (1854) *Helix* pl. 32, figs. 137*a*, 137*b;* Obras Malacológicas (1890) 156, 211, pl. 25, figs. 4–8; Man. Conchol. II 7 (1891) 94, pl. 22, figs. 21–23; pl. 21, figs. 31–33; 9 (1894) 215.

CHLORÆA GEOTROCHUS Moellendorff. RIZAL.

Helix geotrochus MOELLENDORFF, Obras Malacológicas (1890) 157, 212, pl. 27, figs. 5, 6; Man. Conchol. II 7 (1891) 97; 9 (1894) 215.

CHLORÆA GMELINIANA Pfeiffer. LUZON.

Helix gmeliniana PFEIFFER, Proc. Zool. Soc. London (1845) 43; Conchol. Icon. 7 (1854) *Helix* pl. 32, figs. 138*a*, 138*b;* Obras Malacológicas (1890) 156, 211, pl. 143, figs. 7, 8; Man. Conchol. II 7 (1891) 100, pl. 21, figs. 29, 30; 9 (1894) 215; Proc. U. S. Nat. Mus. 55 (1919) 305, pl. 19, figs. 4–6.

CHLORÆA HANLEYI Pfeiffer. LUZON.

Helix hanleyi PFEIFFER, Proc. Zool. Soc. London (1845) 65; Obras Malacológicas (1890) 158, 212, pl. 25, fig. 10; pl. 26, figs. 1–3; Man. Conchol. II 7 (1891) 95, pl. 22, figs. 24–28; 9 (1894) 215; *Helix hugeli* PFEIFFER, Conchol. Icon. 7 (1854) *Helix* pl. 32, figs. 136*a*–136*f;* Obras Malacológicas (1890) 160, 213, pl. 27, figs. 7–10; pl. 135, fig. 8.

CHLORÆA HENNIGIANA Moellendorff. PHILIPPINES.

Helix hennigiana MOELLENDORFF, Obras Malacológicas (1890) 213, pl. 27, figs. 3, 4; Man. Conchol. II 9 (1894) 215.

CHLORÆA MALLEATA Quadras and Moellendorff. LUZON.

Helix malleata QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 209, pl. 144, figs. 7, 8; Nachrichbl. Malak. Ges. 25 (1893) 174.

CHLORÆA LOHERI Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 77.

CHLORÆA PAPYRACEA Broderip. MINDORO; MASBATE; SIQUIJOR.

Abh. Naturf. Ges. 22 (1898) 77. See *Helicostyla papyracea* Broderip.

CHLORÆA PARADOXA Pfeiffer. ALBAY.

Helix paradoxa PFEIFFER, Proc. Zool. Soc. London (1845) 39; Conchol. Icon. 7 (1854) *Helix* pl. 202, fig. 1419; Obras Malacológicas (1890) 164, 214, pl. 24, figs. 1, 2, pl. 144, fig. 10; Man. Conchol. II 7 (1891) 102, pl. 22, figs. 12–14; 9 (1894) 215.

CHLORÆA PSITTACINA Deshayes. LUZON.

Abh. Naturf. Ges. 22 (1898) 75. See *Helicostyla psittacina* Deshayes.

CHLORÆA QUADRASI Moellendorff. CAGAYAN.

Nachrichbl. Malak. Ges. 28 (1896) 9; *Helix quadrasi* MOELLENDORFF, Obras Malacológicas (1890) 208, pl. 143, fig. 10.

CHLORÆA REGINAE Broderip. LUZON.

Abh. Naturf. Ges. 22 (1898) 76. See *Helicostyla reginae* Broderip.

CHLORÆA SIRENA Beck. PANAY; CEBU; MINDANAO.

Helix sirena BECK, Conchol. Icon. 7 (1854) *Helix* pl. 23, figs. 96*a*–96*c*; Obras Malacológicas (1890) 162, 214, pl. 26, figs. 4–11; pl. 135, fig. 7; Man. Conchol. II 7 (1891) 98, pl. 21, figs. 15–20; 9 (1894) 215.

CHLORÆA THERSITES Broderip. MINDORO.

Helix thersites BRODERIP, Proc. Zool. Soc. London (1840) 38; Conchol. Icon. 7 (1854) *Helix* pl. 29, fig. 126; Obras Malacológicas (1890) 156, 211, pl. 23, figs. 5–9; pl. 143, fig. 9; Man. Conchol. II 7 (1891) 104, pl. 21, figs. 11–14; 9 (1894) 216.

CHLORÆA UNDINA Pfeiffer. PHILIPPINES.

Helix undina PFEIFFER, Obras Malacológicas (1890) 213, pl. 134, fig. 6; Man. Conchol. II 7 (1891) 103, pl 22, figs. 8, 9; 9 (1894) 215.

CHLORÆA UNIFASCIATA Moellendorff. ABRA.

Helix unifasciata MOELLENDORFF, Obras Malacológicas (1890) 213; Abh. Naturf. Ges. 22 (1898) 74.

Genus HELICOSTYLA Férussac

(*Cochlostyla* Férussac)

HELICOSTYLA ACCEDENS Moellendorff. NUEVA ECIJA.

Man. Conchol. II 9 (1894) 229.

HELICOSTYLA ACUMINATA Sowerby. CUYO.

Helix acuminata SOWERBY, Proc. Zool. Soc. London (1841) 39; Man. Conchol. 8 (1892) 28, pl. 10, fig. 7; 9 (1894) 229; Obras Malacológicas (1890) 526, pl. 88, fig. 1; pl. 105, fig. 1.

HELICOSTYLA ÆGLE Broderip. MISAMIS; SURIGAO.

Man. Conchol. II 8 (1892) 40, pl. 1, fig. 12; 9 (1894) 230; Reisen Philippinen 3 (1870) 216, pl. 18, fig. 17; Obras Malacológicas (1890) 416, pl. 115, fig. 2; pl. 125, fig. 5; *Cochlostyla barandae* HIDALGO, Obras Malacológicas (1890) 27, 417, pl. 81, fig. 9; pl. 103, fig. 7.

HELICOSTYLA ÆGROTA Reeve. MINDORO; TABLAS; CEBU.

Helix aegrotus REEVE, Conchol. Icon. 7 (1854) *Helix* pl. 22, fig. 95; Obras Malacológicas (1890) 152, 207, pl. 21, fig. 8; Man. Conchol. II 7 (1891) 124, pl. 26, fig. 1; 9 (1894) 219.

HELICOSTYLA ÆRUGINOSA Pfeiffer. BOHOL; PANGLAO.

Helix æruginosa PFEIFFER, Proc. Zool. Soc. London (1854) 56; Conchol. Icon. 7 (1854) *Helix* pl. 183, fig. 1265; Obras Malacológicas (1890) 152, 207, pl. 139, figs. 4, 5; pl. 21, fig. 3; Man. Conchol. II 7 (1891) 122, pl. 26, fig. 6; 9 (1894) 220.

HELICOSTYLA ALBAIENSIS Sowerby. LUZON.

Helix albaiensis SOWERBY, Proc. Zool. Soc. London (1840) 100; Conchol. Icon. 7 (1854) *Helix* pl. 13, figs. 48*a*–48*c;* Man. Conchol. II 7 (1891) 132, pl. 52, figs. 20, 21; 9 (1894) 222; Reisen Philippinen 3 (1870) 176, pl. 8, fig. 7; pl. 18, fig. 14.

HELICOSTYLA ALMAE Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 227, pl. 8, fig. 5. See *Helicostyla reginae* Broderip.

HELICOSTYLA AMICTA Reeve. TABLAS.

Helix amicta REEVE, Conchol. Icon. 7 (1854) *Helix* pl. 14, fig. 52; Man. Conchol. II 7 (1891) 133, pl. 34, figs. 7, 8; 9 (1894) 222; Obras Malacológicas (1890) 470, pl. 48, fig. 4.

HELICOSTYLA ANDROMACHE Pfeiffer. POLILLO.

Helix andromache PFEIFFER, Proc. Zool. Soc. London (1861) 191; Man. Conchol. II 7 (1891) 139; 9 (1894) 222.

HELICOSTYLA ANNAE Semper. BATANES.

Obras Malacológicas (1890) 317, pl. 107, figs. 2, 3; pl. 114, figs. 7, 8; Abh. Naturf. Ges. 22 (1898) 82. See *Helicostyla festiva* Donovan.

HELICOSTYLA ANNULATA Sowerby. ILOCOS PROVINCES.

Helix annulata SOWERBY, Proc. Zool. Soc. London (1840) 135; Conchol. Icon. 7 (1854) *Helix* pl. 26, fig. 110*a*–110*e;* Man. Conchol. II 7 (1891) 174, pl. 39, figs. 85–88; 9 (1894) 226; Obras Malacológicas (1890) 492, pl. 42, figs. 4–8; Proc. U. S. Nat. Mus. 37 (1909) 296; pl. 29, figs. 2, 3, 8, 11, 12.

HELICOSTYLA APLOMORPHA Jonas. MINDORO.

Man. Conchol. II 8 (1892) 11, pl. 12, fig. 11; 9 (1894) 228; Obras Malacológicas (1890) 413, pl. 103, fig. 1.

HELICOSTYLA AURATA Sowerby. NORTHERN LUZON.

Helix aurata SOWERBY, Proc. Zool. Soc. London (1840) 100; Conchol. Icon. 7 (1854) *Helix* pl. 13, figs. 46*b*, 46*c;* Obras Malacológicas (1890) 214, 165, pl. 24, fig. 7; Man. Conchol. II 7 (1891) 170, pl. 56, figs. 68–70; pl. 26, figs. 4, 5, 7; 9 (1894) 221.

HELICOSTYLA BALANOIDEA Jonas. MINDORO.

Man. Conchol. II 8 (1892) 44, pl. 6, figs. 17–20; 9 (1894) 231; Obras Malacológicas (1890) 503, pl. 98, figs. 8, 9.

HELICOSTYLA BALTEATA Sowerby. ILOCOS PROVINCES.

Helix balteata SOWERBY, Proc. Zool. Soc. London (1840) 136; Conchol. Icon. 7 (1854) *Helix* pl. 25, figs. 71*a*–71*c*; Man. Conchol. II 7 (1891) 173, pl. 39, figs. 89–93; 9 (1894) 226; Reisen Philippinen 3 (1870) 197, pl. 18, fig. 24; Obras Malacológicas (1890) 493, pl. 42, figs. 9–11; pl. 52, fig. 7.

HELICOSTYLA BELCHERI Pfeiffer. TAYABAS.

Man. Conchol. II 8 (1892) 35, pl. 8, figs. 45, 46; 9 (1894) 230; Obras Malacológicas (1890) 524, pl. 116, fig. 7; *Cochlostyla hindsii* REEVE, 412, pl. 159, fig. 1.

HELICOSTYLA BELONI Jouss. PHILIPPINES.

Man. Conchol. II 9 (1894) 224.

HELICOSTYLA BEMBICODES Pfeiffer. ROMBLON.

Man. Conchol. II 7 (1891) 198, pl. 31, figs. 36, 37; 9 (1894) 227; Obras Malacológicas (1890) 357, pl. 56, fig. 1.

HELICOSTYLA BICOLORATA Lea. LUZON; MARINDUQUE.

Man. Conchol. II 7 (1891) 199, pl. 44, figs. 40, 41; 9 (1894) 227; Obras Malacológicas (1890) 401, pl. 65, figs. 2–5; pl. 70, figs. 4, 5; pl. 120, fig. 2; Abh. Naturf. Ges. 22 (1898) 110.

HELICOSTYLA BOETTGERIANA Moellendorff. BULACAN; RIZAL.

Man. Conchol. II 7 (1891) 180; 9 (1894) 225; Obras Malacológicas (1890) 444, pl. 50, fig. 6.

HELICOSTYLA BREVICULA Pfeiffer. ROMBLON.

Man. Conchol. II 8 (1892) 45, 7 (1891) pl. 47, fig. 64; 9 (1894) 231; Obras Malacológicas (1890) 488, pl. 117, fig. 1.

HELICOSTYLA BRODERIPI Pfeiffer. SIQUIJOR.

Helix broderipi PFEIFFER, Conchol. Icon. 7 (1854) *Helix* pl. 21, fig. 88; Obras Malacológicas (1890) 204, pl. 133, figs. 6, 7; Man. Conchol. II 7 (1891) 123, pl. 24, figs. 27, 28, 32, 33; 9 (1894) 220.

HELICOSTYLA BRUGUIERIANA Pfeiffer. TABLAS.

Helix bruguieriana PFEIFFER, Proc. Zool. Soc. London (1845) 44; Conchol. Icon. 7 (1854) *Helix* pl. 8, fig. 38; Man. Conchol. II 7 (1891) 166, pl. 40, figs. 6, 7; pl. 57, figs. 77, 78; 9 (1894) 224.

HELICOSTYLA BUTLERI Pfeiffer. MOUNTAIN PROVINCE; NUEVA ECIJA.

Helix butleri PFEIFFER, Proc. Zool. Soc. London (1842) 87; Conchol. Icon. 7 (1854) *Helix* pl. 8, fig. 37; Man. Conchol. II 7 (1891) 188, pl. 37, figs. 50, 51; 9 (1894) 225; Obras Malacológicas (1890) 449, pl. 34, fig. 8; pl. 36, figs. 7, 8; pl. 109, fig. 5; Reisen Philippinen 3 (1870) 193, pl. 13, figs. 2, 3, 6; pl. 18, fig. 13.

HELICOSTYLA CÆSAR Pfeiffer. PHILIPPINES.

Man. Conchol. II 8 (1892) 15, pl. 5, fig. 1; 9 (1894) 228; Obras Malacológicas (1890) 483, pl. 63, fig. 2.

HELICOSTYLA CAILLIAUDI Deshayes. LUZON; MINDANAO.

Helix cailliaudi DESHAYES, Conchol. Icon. 7 (1854) *Helix* pl. 8, fig. 33; Man. Conchol. II 7 (1891) 144, pl. 50, figs. 2, 3; pl. 52, figs. 26, 27; 9 (1894) 222; Obras Malacológicas (1890) 342, pl. 44, figs. 2; pl. 104, fig. 1; pl. 111, fig. 4; pl. 112, fig. 4; pl. 121, fig. 4; pl. 128, figs. 4–6; *Helix ferruginea* LEA, Trans. Am. Phil. Soc. Phila. 10 (1852) 10, pl. 12, fig. 17.

HELICOSTYLA CALAMIANICA Quadras and Moellendorff. MINDORO; CUYO; BUSUANGA.

Man. Conchol. II 9 (1894) 231; Obras Malacológicas (1890) 513, pl. 93, figs. 3–6; Nachrichbl. Malak. Ges. 26 (1894) 99.

HELICOSTYLA CALOBAPTA Jonas. MINDORO; TABLAS; CEBU.

Man. Conchol. II 8 (1892) 46, pl. 15, figs. 7–9; 9 (1894) 231; Obras Malacológicas (1890) 512, pl. 88, figs. 2–6; pl. 120, figs. 5, 6; pl. 127, fig. 5; Abh. Naturf. Ges. 22 (1898) 119.

HELICOSTYLA CALUSAENSIS Bartsch. CALUGA ISLAND, CAGAYANES GROUP.

Proc. U. S. Nat. Mus. 45 (1913) 550, pl. 43, figs. 9, 10, 12–14.

HELICOSTYLA CALYPSO Broderip. NEGROS.

Man. Conchol. II 8 (1892) 25, pl. 12, fig. 3; 9 (1894) 229; Obras Malacológicas (1890) 519, pl. 119, fig. 7.

HELICOSTYLA CAMELOPARDALIS Broderip. CEBU; CAMOTES ISLANDS; LEYTE.

Man. Conchol. II 8 (1892) 25, pl. 12, figs. 4, 5; 9 (1894) 229; Reisen Philippinen 3 (1870) 208, pl. 10, fig. 13; pl. 18, fig. 19; *Cochlostyla connectens* MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 97, pl. 3, fig. 9; Abh. Naturf. Ges. 22 (1898) 117; Obras Malacológicas (1890) 542, pl. 74, figs. 3, 4; pl. 93, fig. 8; *Cochlostyla boholensis* BRODERIP, 540, pl. 74, figs. 7, 8; pl. 127, figs. 3, 4; pl. 74, figs. 5, 6; pl. 86, figs. 1, 2; pl. 127, fig. 7.

HELICOSTYLA CARBONARIA Sowerby. CEBU.

Helix carbonaria SOWERBY, Proc. Zool. Soc. London (1842) 86; Conchol. Icon. 7 (1854) *Helix* pl. 16, figs. 63*a*, 63*b*; Man. Conchol. II 7 (1891) 163, pl. 43, figs. 30–32; pl. 44, fig. 33; 9 (1894) 224; Obras Malacológicas (1890) 145, 202, pl. 102, figs. 9; pl. 12, figs. 6, 7; pl. 132, figs. 4, 5; pl. 145, fig. 3.

HELICOSTYLA CARINATA Lea. TAYABAS; ALBAY.

Man. Conchol. II 8 (1892) 22, pl. 13, figs. 53, 54; 9 (1894) 228; Obras Malacológicas (1890) 553, pl. 75, figs. 1–6; pl. 113, fig. 68; pl. 105, figs. 1, 2; pl. 80, fig. 1; pl. 93, fig. 8; Proc. U. S. Nat. Mus. 55 (1919) 303, pl. 18, fig. 5; Abh. Naturf. Ges. 22 (1898) 118.

HELICOSTYLA CARNEOLA Grateloup. MANILA (?).

Man. Conchol. II 8 (1892) 19, pl. 7, fig. 41; 9 (1894) 228.

HELICOSTYLA CASTA Pfeiffer. PHILIPPINES.

Helix casta PFEIFFER, Obras Malacológicas (1890) 146, 203, pl. 133, figs. 2, 3; Man. Conchol. II 7 (1891) 120; pl. 25, figs. 37, 38; 9 (1894) 219.

HELICOSTYLA CEPOIDES Lea. LUBANG.

Helix cepoides LEA, Proc. Zool. Soc. London (1840) 88; Trans. Am. Phil. Soc. Phila. **10** (1852) 8, pl. 12, fig. 14; Conchol. Icon. 7 (1854) *Helix* pl. 8, fig. 39; Man. Conchol. II 7 (1891) 194, pl. 48, fig. 69; **9** (1894) 226; *Nanina cepoides* LEA, **2** (1885) 26, pl. 6, figs. 86, 87; Obras Malacológicas (1890) 352, pl. 44, figs. 3–5.

HELICOSTYLA CHIONODES Moellendorff. ROMBLON.

Nachrichbl. Malak. Ges. **28** (1896) 9.

HELICOSTYLA CHLOROCHROA Sowerby. BOHOL; MINDANAO.

Helix chlorochroa SOWERBY, Proc. Zool. Soc. London (1841) 2; Conchol. Icon. 7 (1854) *Helix* pl. 7, fig. 27; Man. Conchol. II 7 (1891) 150, pl. 37, figs. 38, 39; **9** (1894) 223; Obras Malacológicas (1890) 363, pl. 121, fig. 1.

HELICOSTYLA CHRYSALIDIFORMIS Sowerby. MINDORO.

Man. Conchol. II **8** (1892) 51, pl. 14, figs. 64–67; **9** (1894) 215, 231; Obras Malacológicas (1890) 550, pl. 105, figs. 3, 4; pl. 155, figs. 8, 9; *Cochlostyla antonii* SEMPER, Reisen Philippinen **3** (1870) 223; Obras Malacológicas (1890) 547, pl. 97, figs. 1, 2; pl. 106, fig. 1.

HELICOSTYLA CHRYSOCHILA Sowerby. BATANES; NORTH LUZON.

Helix chrysocheila SOWERBY, Proc. Zool. Soc. London (1841) 3; Conchol. Icon. 7 (1854) *Helix* pl. 5, fig. 25; Man. Conchol. II 7 (1891) 138, pl. 34, fig. 9, 10; **9** (1894) 222; Obras Malacológicas (1890) 342, pl. 30, figs. 3, 4; pl. 36, fig. 6.

HELICOSTYLA CINCINNA Sowerby. ROMBLON; TEMPLE; BURIAS.

Helix cincinnus SOWERBY, Proc. Zool. Soc. London (1840) 98; Man. Conchol. II **8** (1892) 16, pl. 10, figs. 1–5; **9** (1894) 228; Obras Malacológicas (1890) 530, pl. 81, figs. 4–8; pl. 142, fig. 6; *Cochlostyla gracilis* LEA, 531, pl. 86, figs. 3–6; pl. 116, fig. 8; *Cochlostyla virens* PFEIFFER, 532, pl. 86, fig. 8; pl. 93, fig. 7; *Cochlostyla romblonensis* PFEIFFER, 535, pl. 71, figs. 1–3; pl. 79, figs. 5, 6; pl. 92, figs. 3–6.

HELICOSTYLA CINCINNIFORMIS Sowerby. LUBANG.

Helix cincinniformis SOWERBY, Proc. Zool. Soc. London (1840) 17; Man. Conchol. II **8** (1892) 18, pl. 6, figs. 21, 22, 24; **9** (1894) 228; Obras Malacológicas (1890) 528, pl. 71, figs. 4–6.

HELICOSTYLA CINERACEA Semper. SURIGAO.

Man. Conchol. II 7 (1891) 168, pl. 59, fig. 3; **9** (1894) 224; Reisen Philippinen **3** (1870) 190, pl. 9, figs. 1*a*, *b*. See *Helicostyla cryptica* Broderip.

HELICOSTYLA CINERASCENS Pfeiffer. MASBATE; MINDORO.

Helix cinerascens PFEIFFER, Proc. Zool. Soc. London (1845) 64, Conchol. Icon. 7 (1854) *Helix* pl. 19, figs. 78*a*, 78*b*; Man. Conchol. II 7 (1891) 197, pl. 47, fig. 60; **9** (1894) 227; Obras Malacológicas (1890) 356, pl. 56, fig. 2; *Helix turbo* PFEIFFER, Proc. Zool. Soc. London (1845) 64; Conchol. Icon. 7 (1854) *Helix* pl. 19, fig. 81; Obras Malacológicas (1890) 355, pl. 68, figs. 4, 5.

HELICOSTYLA CINEROSA Pfeiffer. PALAWAN.

Mon. Conchol. II **8** (1892) 15, pl. 1, fig. 4; **9** (1894) 228; Obras Malacológicas (1890) 426, pl. 116, fig. 5; Proc. Bio. Soc. Wash. **32** (1919) 177–179, many figures.

HELICOSTYLA COCCOMELOS Sowerby. TABLAS; SAMAR.

Helix coccomelos SOWERBY, Proc. Zool. Soc. London (1840) 167; Man. Conchol. II **7** (1891) 146, pl. 55, figs. 51–55; **9** (1894) 222; Obras Malacológicas (1890) 295, pl. 32, figs. 1–8; pl. 37, figs. 6, 7; pl. 104, fig. 3; pl. 126, fig. 1.

HELICOSTYLA CODONENSIS Hidalgo. CATANDUANES.

Obras Malacológicas (1890) 50; 439, pl. 40, figs. 4–6; Man. Conchol. II **7** (1891) 140, pl. 53, fig. 37; **9** (1894) 222.

HELICOSTYLA COLLODES Sowerby. TABLAS; CEBU; ZAMBOANGA.

Helix collodes SOWERBY, Proc. Zool. Soc. London (1840) 102; Conchol. Icon. **7** (1854) *Helix* pl. 16, figs. 64*a*, 64*b*, 65; Man. Conchol. II **7** (1891) 184, pl. 46, figs. 56, 57; **9** (1894) 224; Obras Malacológicas (1890) 468, pl. 48, figs. 5, 6; pl. 122, fig. 7; pl. 139, fig. 7.

HELICOSTYLA CONCINNA Sowerby. NORTHERN LUZON.

Helix concinna SOWERBY, Proc. Zool. Soc. London (1841) 20; Man. Conchol. II **8** (1892) 27, pl. 11, figs. 26–28; **9** (1894) 229; Reisen Philippinen **3** (1870) 206, pl. 13, fig. 11; pl. 18, fig. 18; *Cochlostyla flammula* SEMPER, pl. 9, fig. 2; Obras Malacológicas (1890) 540, No. 482, pl. 85, fig. 8; pl. 127, fig. 8; Obras Malacológicas (1890) 538, pl. 57, figs. 1, 2; pl. 120, fig. 4; *Cochlostyla flammula* SEMPER, 540, pl. 85, fig. 8; pl. 127, fig. 8.

HELICOSTYLA CORONADOI Hidalgo. CATANDUANES; LEYTE.

Man. Conchol. II **7** (1891) 142, pl. 34, figs. 5, 6; pl. 35, fig. 21; **9** (1894) 222; Obras Malacológicas (1890) 324, 13, pl. 38, figs. 1, 2.

HELICOSTYLA COSSMANNIANA Crosse. MARINDUQUE.

Man. Conchol. II **8** (1892) 34, pl. 5, figs. 8, 9; **9** (1894) 230; Obras Malacológicas (1890) 521, pl. 98, fig. 1. See *Helicostyla simplex* Jonas.

HELICOSTYLA CROMYODES Pfeiffer. MISAMIS.

Helix cromyodes PFEIFFER, Proc. Zool. Soc. London (1842) 150; Conchol. Icon. **7** (1854) *Helix* pl. 203, fig. 1429; Man. Conchol. II **7** (1891) 139, pl. 29; figs. 13–16; **9** (1894) 222; *Cochlostyla valenciennesii* EYDOUX, Reisen Philippinen **3** (1870) 169; Conchol. Icon. **7** (1854) *Helix* pl. 21, fig. 87; Obras Malacológicas (1890) 283, pl. 45, figs. 1–5.

HELICOSTYLA CROSSEI Hidalgo. TABLAS.

Man. Conchol. II **7** (1891) 156, pl. 56, figs. 57, 58; **9** (1894) 223; Obras Malacológicas (1890) 27, 478, pl. 66, figs. 5, 6.

HELICOSTYLA CRYPTICA Broderip. BOHOL; NORTHERN SAMAR; EASTERN MINDANAO.

Helix cryptica BRODERIP, Proc. Zool. Soc. London (1840) 22; Conchol. Icon. **7** (1854) *Helix* pl. 3, fig. 7; Obras Malacológicas (1890) 347,

pl. 33, fig. 1; pl. 126, fig. 5; pl. 112, fig. 7; pl. 126, fig. 4; Man. Conchol. II **7** (1891) 167, pl. 50, fig. 1; pl. 51, fig. 9; **9** (1894) 224; *Cochlostyla latitans* BRODERIP, Reisen Philippinen **3** (1870) 188, pl. 18, fig. 15; *Helix latitans* BRODERIP, Proc. Zool. Soc. London (1840) 23; Obras Malacológicas (1890) 349, pl. 35, figs. 1, 2; pl. 52, fig. 3; pl. 141, fig. 4; Conchol. Icon. **7** (1854) *Helix* pl. 3, fig. 10; *Helix cretata* BRODERIP, Proc. Zool. Soc. London (1840) 23, Conchol. Icon. **7** (1854) *Helix* pl. 3, fig. 13; Obras Malacológicas (1890) 350, pl. 31, figs. 1, 2.

HELICOSTYLA CUMINGI Pfeiffer. CAMIGUIN, MINDANAO.

Man. Conchol. II **8** (1892) 39, pl. 9, fig. 63; **9** (1894) 230; Obras Malacológicas (1890) 419, pl. 59, fig. 1.

HELICOSTYLA CUNCTATOR Reeve. CEBU.

Man. Conchol. II **7** (1891) 202; **8** (1892) pl. 12, figs. 1, 2; **9** (1894) 227.

HELICOSTYLA CURTA Sowerby. NORTHERN LUZON.

Helix curta SOWERBY, Proc. Zool. Soc. London (1841) 20; Conchol. Icon. **7** (1854) *Helix* pl. 8, fig. 34; Man. Conchol. II **7** (1891) 192, pl. 37, figs. 47, 48; **9** (1894) 225; Obras Malacológicas (1890) 436, pl. 57, figs. 5–8.

HELICOSTYLA CUYOËNSIS Pfeiffer. CUYO.

Man. Conchol. II **8** (1892) 47; **9** (1894) 231; Obras Malacológicas (1890) 516, pl. 119, fig. 1.

HELICOSTYLA DAMAHOYI Pfeiffer. BATANES.

Helix damahoyi PFEIFFER, Proc. Zool. Soc. London (1856) 328; Man. Conchol. II **7** (1891) 143, pl. 37, figs. 40–42; **9** (1894) 223; Reisen Philippinen **3** (1870) 175, pl. 18, fig. 8; Obras Malacológicas (1890) 313, pl. 114, figs. 1, 2.

HELICOSTYLA DAPHNIS Broderip. BOHOL; SIQUIJOR; CEBU.

Helix daphnis BRODERIP, Proc. Zool. Soc. London (1840) 180; Man. Conchol. II **7** (1891) 201, pl. 42, figs. 20–23; **9** (1894) 227; Obras Malacológicas (1870) 387, pl. 60, figs. 1–4; pl. 70, fig. 3; pl. 123, figs. 5, 6; pl. 119, fig. 5.

HELICOSTYLA DATAENSIS Semper. MOUNTAIN PROVINCE.

Obras Malacológicas (1890) 351, pl. 83, fig. 2; pl. 126, figs. 2, 3; Man. Conchol. II **7** (1891) 169, pl. 51, figs. 13–15; **9** (1894) 224; Reisen Philippinen **3** (1870) 186, pl. 8, fig. 8; pl. 13, fig. 17.

HELICOSTYLA DAUTZENBERGI Hidalgo. LUZON.

Obras Malacológicas (1890) 288, pl. 146, figs. 4–6.

HELICOSTYLA DEALBATA Broderip. SIQUIJOR.

Helix dealbata BRODERIP, Proc. Zool. Soc. London (1841) 45; Obras Malacológicas (1890) 146, 203, pl. 133, fig. 1; Man. Conchol. II **7** (1891) 119, pl. 21, fig. 36; **9** (1894) 219.

HELICOSTYLA DECIPIENS Sowerby. LUZON; CAPUL.

Helix decipiens SOWERBY, Proc. Zool. Soc. London (1840) 96; Conchol. Icon. **7** (1854) *Helix* pl. 5, fig. 23; Man. Conchol. II **7** (1891) 140, pl. 29, figs. 10, 11; **9** (1894) 222; *Cochlostyla sowerbyi* HIDALGO, Obras Malacológicas (1890) 336, pl. 121, fig. 5.

HELICOSTYLA DECORA Adams and Reeve. MINDORO; ROMBLON.

Helix decora ADAMS and REEVE, H. M. S. Samarang, Voy. Zool. Publ. London (1850) 62, pl. 16, fig. 7; Conchol. Icon. 7 (1854) *Helix* pl. 105, fig. 586; Man. Conchol. II 7 (1891) 133, pl. 52, figs. 23, 24; 9 (1894) 222; Obras Malacológicas (1890) 470, pl. 124, fig. 6.

HELICOSTYLA DENTICULATA Jay. PHILIPPINES.

Obras Malacológicas (1890) 293, pl. 146, figs. 7, 8; Abh. Naturf. Ges. 22 (1898) 84.

HELICOSTYLA DEPRESSA Semper. MINDANAO.

Man. Conchol. II 7 (1891) 149, pl. 50, figs. 4–8; 9 (1894) 223; Obras Malacológicas (1890) 326, pl. 31, figs. 3–6; pl. 45, figs. 6, 7; pl. 107, fig. 1; pl. 141, fig. 6; pl. 41, figs. 1, 2; *Helix lignaria* PFEIFFER, Proc. Zool. Soc. London (1846) 111; Conchol. Icon. 7 (1854) *Helix* pl. 9, fig. 40.

HELICOSTYLA DIANA Broderip. NEGROS.

Man. Conchol. II 8 (1892) 24, pl. 11, figs. 22, 23, 30, 31; 9 (1894) 228; Obras Malacológicas (1890) 545, pl. 110, figs. 7, 8; *Cochlostyla calista* BRODERIP, 543, pl. 74, figs. 1, 2; pl. 79, figs. 3, 4.

HELICOSTYLA DIFFICILIS Pfeiffer. PHILIPPINES.

Helix difficilis PFEIFFER, Proc. Zool. Soc. London (1853) 127; Conchol. Icon. 7 (1854) *Helix* pl. 183, fig. 1269; Man. Conchol. II 7 (1891) 151, pl. 48, fig. 72; 9 (1894) 223; Obras Malacológicas (1890) 293, pl. 131, fig. 8.

HELICOSTYLA DILATATA Pfeiffer. LA UNION.

Obras Malacológicas (1890) 435, pl. 116, figs. 1, 2; Abh. Naturf. Ges. 22 (1898) 98.

HELICOSTYLA DIMERA Jonas. MINDORO; TABLAS.

Helix dimera JONAS, Conchol. Icon. 7 (1854) *Helix* pl. 15, fig. 61; Man. Conchol. II 7 (1891) 156, pl. 30, figs. 29, 30; 9 (1894) 223; Obras Malacológicas (1890) 481, pl. 48, figs. 7, 8; pl. 124, figs. 7, 8.

HELICOSTYLA DOMINGOI Bartsch. NUEVA VIZCAYA.

Proc. U. S. Nat. Mus. 55 (1919) 304, pl. 20, fig. 1–3.

HELICOSTYLA DRYAS Broderip. MINDORO.

Man. Conchol. II 8 (1892) 49, pl. 16, figs. 18, 19, 25; 9 (1894) 231.

HELICOSTYLA DUBIOSA Pfeiffer. BATANES; LUZON; SAMAR.

Helix dubiosa PFEIFFER, Proc. Zool. Soc. London (1845) 123; Conchol. Icon. 7 (1854) pl. 5, fig. 22; *Helix speciosa*, pl. 10, figs. 42*a*–42*f*; *Helix batanica* REEVE, pl. 9, figs. 2*a*, 2*b*; Man. Conchol. II 7 (1891) 135, pl. 32, figs. 52, 54; 9 (1894) 222; Obras Malacológicas (1890) 303, pl. 47, figs. 2–5; *Cochlostyla speciosa* JAY, 313, pl. 28, figs. 3–6.

HELICOSTYLA DUMONTI Pfeiffer. MINDORO.

Helix dumonti PFEIFFER, Conchol. Icon. 7 (1854) *Helix* pl. 23, fig. 102; Man. Conchol. II 8 (1892) 42, pl. 9, fig. 67; 9 (1894) 230; Obras Malacológicas (1890) 489, pl. 81, figs. 2, 3; pl. 123, fig. 1.

HELICOSTYLA EBURNEA Reeve. TAYABAS; ALBAY.

Man. Conchol. II **8** (1892) 20, pl. 10, figs. 9, 11; **9** (1894) 228; Obras Malacológicas (1890) 438, pl. 115, fig. 1.

HELICOSTYLA EFFUSA Pfeiffer. TABLAS.

Man. Conchol. II **8** (1892) 31, pl. 7, figs. 42, 43; **9** (1894) 229; Obras Malacológicas (1890) 446, pl. 53, figs. 4–6.

HELICOSTYLA ELECTRICA Reeve. MINDORO.

Man. Conchol. II **8** (1892) 53, pl. 15, figs. 3–6; **9** (1894) 231; Obras Malacológicas (1890) 552, pl. 113, fig. 3; pl. 155, figs. 5–7.

HELICOSTYLA ELEGANS Semper. SIQUIJOR.

Man. Conchol. II **8** (1892) 21, pl. 13, fig. 55; **9** (1894) 228; *Cochlostyla siquijorensis* PFEIFFER, Obras Malacológicas (1890) 546, pl. 115, fig. 5.

HELICOSTYLA ELERAE Moellendorff. TAYABAS.

Nachrichbl. Malak. Ges. **28** (1896) 87.

HELICOSTYLA ERUBESCENS Semper. CAGAYAN.

Man. Conchol. II **7** (1891) 170, pl. 56, figs. 64, 65; **9** (1894) 221; Reisen Philippinen **3** (1870) 182, pl. 9, fig. 8; pl. 10, fig. 12; Obras Malacológicas (1890) 281, pl. 130, figs. 7–9; *Helix luteocincta* SEMPER, 214, 166, pl. 130, figs. 2, 3.

HELICOSTYLA ERYTHROSPIRA Moellendorff. ISABELA.

Man. Conchol. II **7** (1891) 137; **9** (1894) 222; Obras Malacológicas (1890) 318, pl. 83, figs. 3, 4; pl. 129, fig. 6; pl. 159, fig. 4.

HELICOSTYLA EVANESCENS Broderip. LUZON.

Man. Conchol. II **8** (1892) 20, pl. 7, fig. 38; **9** (1894) 228; Obras Malacológicas (1890) 518, pl. 80, figs. 2–4; Abh. Naturf. Ges. **22** (1898) 109.

HELICOSTYLA EYDOUXI Hidalgo. CAPUL.

Helix eydouxi HIDALGO, Obras Malacológicas (1890) 25, 152, 207, pl. 22, fig. 4; Man. Conchol. II **7** (1891) 123, pl. 26, figs. 8, 9; **9** (1894) 220.

HELICOSTYLA FAUNUS Broderip. CEBU; CAMOTES ISLANDS; MASBATE.

Helix faunus BRODERIP, Proc. Zool. Soc. London (1840) 180; Man. Conchol. II **7** (1891) 203, pl. 61, figs. 17–19; **9** (1894) 227; Obras Malacológicas (1890) 395, pl. 62, figs. 4, 5; pl. 104, fig. 6.

HELICOSTYLA FENESTRATA Sowerby. CAGAYAN; NUEVA ECIJA.

Helix fenestrata SOWERBY, Proc. Zool. Soc. London (1840) 137; Conchol. Icon. **7** (1854) *Helix* pl. 14, figs. 50*a*, 50*b*; Man. Conchol. II **7** (1891) 192, pl. 58, figs. 95, 96; **9** (1894) 225; Obras Malacológicas (1890) 471, pl. 117, fig. 8; pl. 52, figs. 4–6.

HELICOSTYLA FESTIVA Donovan. CAGAYAN; PAMPANGA.

Helix festiva DONOVAN, Conchol. Icon. **7** (1854) *Helix* pl. 25, figs. 107*a*, 107*b*; Man. Conchol. II **7** (1891) 134, pl. 52, fig. 25; pl. 35, figs. 11–16; **9** (1894) 222; Obras Malacológicas (1890) 310, pl. 29, fig. 2, pl. 96, fig. 1, 2, pl. 128, figs. 1–3. See *Helicostyla luzonica* Sowerby.

HELICOSTYLA FICTILIS Broderip. MINDORO; CUYO; LEYTE; MINDANAO.

Man. Conchol. II **8** (1892) 47, pl. 16, figs. 16, 17; **9** (1894) 231; Obras Malacológicas (1890) 514, pl. 88, figs. 7, 8; pl. 142; figs. 1–3; *Cochlostyla larvata* BRODERIP, 515, pl. 119, fig. 2.

HELICOSTYLA FILARIS Valenciennes. MARINDUQUE; ZAMBOANGA.

Helix filaris VALENCIENNES, Proc. Zool. Soc. London (1845) 38; Conchol. Icon. **7** (1854) *Helix* pl. 21, fig. 84; Obras Malacológicas (1890) 152, 207, pl. 23, figs. 1–4; Man. Conchol. II **7** (1891) 122, pl. 25, figs. 52–54; pl. 26, figs. 10–12; **9** (1894) 220; *Helix nympha* PFEIFFER, Proc. Zool. Soc. London (1849) 129; Conchol. Icon. **7** (1854) *Helix* pl. 21, fig. 85.

HELICOSTYLA FISCHERI Hidalgo. BUSUANGA.

Man. Conchol. II **8** (1892) 29, pl. 10, fig. 15; **9** (1894) 228; Obras Malacológicas (1890) 53, 516, pl. 29, fig. 7; pl. 110, figs. 1–5; Abh. Naturf. Ges. **22** (1898) 119.

HELICOSTYLA FLORIDA Sowerby. MINDORO.

Helix florida SOWERBY, Proc. Zool. Soc. London (1840) 87; Conchol. Icon. **7** (1854) *Helix* pl. 11, figs. 43*a*–43*c*; *Helix helicoides* PFEIFFER, pl. 17, fig. 72; Man. Conchol. II **7** (1891) 177, pl. 38, figs. 70–73; **9** (1894) 225; Obras Malacológicas (1890) 455, pl. 39, figs. 2–8.

HELICOSTYLA FRAGILIS Sowerby. LEYTE.

Helix fragilis SOWERBY, Proc. Zool. Soc. London (1841) 40; Obras Malacológicas (1890) 149, 205, pl. 24, figs. 8, 9; Man. Conchol. II **7** (1891) 129, pl. 29, figs. 5, 6; **9** (1894) 221; *Helix leytensis* PFEIFFER, Conchol. Icon. **7** (1854) *Helix* pl. 15, fig. 56.

HELICOSTYLA FULGETRUM Broderip. GUIMARAS; NEGROS.

Man. Conchol. II **8** (1892) 12, pl. 4, figs. 32–35; **9** (1894) 228; Obras Malacológicas (1890) 407, pl. 78, figs. 3–5; Proc. Biol. Soc. Wash. **32** (1919) 16.

HELICOSTYLA FULIGINATA Martens. LUZON.

Man. Conchol. II **7** (1891) 188; **9** (1894) 225.

HELICOSTYLA GARIBALDIANA Dohrn and Semper. NORTHERN LUZON.

Helix garibaldiana DOHRN and SEMPER, Obras Malacológicas (1890) 143, 199, pl. 131, fig. 1; pl. 134, figs. 7, 8; pl. 135, figs. 1, 2; Man. Conchol. II **7** (1891) 159, pl. 20, figs. 1, 2; **9** (1894) 223; Nachrichbl. Malak. Ges. **28** (1896) 10.

HELICOSTYLA GENERALIS Pfeiffer. CAMARINES NORTE.

Helix generalis PFEIFFER, Proc. Zool. Soc. London (1854) 123; Conchol. Icon. **7** (1854) *Helix* pl. 192, fig. 1349; Man. Conchol. II **7** (1891) 137; pl. 52, fig. 22; **9** (1894) 222; Obras Malacológicas (1890) 364, pl. 118, figs. 1, 2.

HELICOSTYLA GIGAS Hidalgo. CAMARINES SUR; CATANDUANES.

Obras Malacológicas (1890) 367, pl. 53, figs. 1, 2; pl. 54, fig. 1. See *Helicostyla turbinoides* Broderip.

HELICOSTYLA GILBERTI Quadras and Moellendorff. TAYABAS.

Obras Malacológicas (1890) 341, pl. 128, fig. 7; Nachrichbl. Malak. Ges. **28** (1896) 10.

HELICOSTYLA GILVA Broderip. BOHOL; SIQUIJOR; MINDANAO.

Man. Conchol. II 7 (1891) 205, pl. 42, figs. 24–26; 9 (1894) 227; Obras Malacológicas (1890) 383, pl. 62, figs. 1, 2.

HELICOSTYLA GLAUCOPHTHALMA Pfeiffer. PHILIPPINES.

Man. Conchol. II 8 (1892) 7, pl. 1, fig. 3; 9 (1894) 228; Obras Malacológicas (1890) 479, pl. 109, fig. 8.

HELICOSTYLA GLOBOSULA Moellendorff. NUEVA ECIJA.

Cochlostyla globosula MOELLENDORFF, Nachrichbl. Malak. Ges. 26 (1894) 96; Man. Conchol. II 9 (1894) 220.

HELICOSTYLA GRAELLSI Hidalgo. BALABAC.

Man. Conchol. II 8 (1892) 14, pl. 5, figs. 2, 3; 9 (1894) 228; Obras Malacológicas (1890) 16, 425, pl. 63, figs. 3, 4. See *Helicostyla satyrus* Broderip.

HELICOSTYLA GRANDIS Pfeiffer. NORTHERN LUZON.

Helix grandis PFEIFFER, Proc. Zool. Soc. London (1845) 43; Conchol. Icon. 7 (1854) *Helix* pl. 7, fig. 30; Man. Conchol. II 7 (1891) 195, pl. 59, figs. 7, 8; pl. 60, figs. 9–11; pl. 48, figs. 66–68; 9 (1894) 227; Reisen Philippinen 3 (1870) 199; Obras Malacológicas (1890) 385, pl. 41, fig. 3; pl. 43, fig. 2; pl. 44, fig. 1; *Cochlostyla carolus* DESHAYES, 353, pl. 40, fig. 1; pl. 52, fig. 2; pl. 129, figs. 1, 2; pl. 139, fig. 6.

HELICOSTYLA GROULTI Jouss. CENTRAL PHILIPPINES.

Man. Conchol. II 9 (1894) 228.

HELICOSTYLA HAINESI Pfeiffer. PHILIPPINES.

Man. Conchol. II 8 (1892) 26; 9 (1894) 229.

HELICOSTYLA HALICHLORA Semper. BATANES; BABUYANES.

Man. Conchol. II 8 (1892) 32; 7 (1891) pl. 27, figs. 4, 5; 9 (1894) 229; Obras Malacológicas (1890) 487, pl. 112, fig. 3.

HELICOSTYLA HARFORDII Sowerby. NEGROS.

Helix harfordii SOWERBY, Proc. Zool. Soc. London (1840) 123; Conchol. Icon. 7 (1854) *Helix* pl. 8, fig. 36; Man. Conchol. II 7 (1891) 148, pl. 55, figs. 49, 50; 9 (1894) 223; Obras Malacológicas (1890) 361, pl. 83, fig. 1; pl. 84, fig. 1.

HELICOSTYLA HEERMANNI Moellendorff. LUZON.

Helix heermanni MOELLENDORFF, Obras Malacológicas (1890) 201, pl. 136, figs. 1, 2; Abh. Naturf. Ges. 22 (1898) 94.

HELICOSTYLA HEMISPHÆRION Pfeiffer. PHILIPPINES.

Man. Conchol. II 7 (1891) 145, pl. 54, figs. 45, 46; 9 (1894) 222; Obras Malacológicas (1890) 286, pl. 111, figs. 2, 3.

HELICOSTYLA HIDALGOI Moellendorff. SIBUYAN.

Man. Conchol. II 8 (1892) 246; 7 (1891) pl. 54, figs. 41, 42; 9 (1894) 223; Obras Malacológicas (1890) 299, pl. 34, figs. 1, 2; pl. 159, fig. 2; Nachrichbl. Malak. Ges. 26 (1894) 96.

HELICOSTYLA HOLOLEUCA Pfeiffer. PHILIPPINES.

Man. Conchol. II 8 (1892) 37; 9 (1894) 229.

HELICOSTYLA HYDROPHANA Sowerby. MINDORO.

Helix hydrophana SOWERBY, Proc. Zool. Soc. London (1840) 88; Conchol. Icon. 7 (1854) *Helix* pl. 17, figs. 69*a*, 69*b*; Man. Conchol. II 7 (1891) 187, pl. 36, figs. 35–37; 9 (1894) 225.

HELICOSTYLA IGNOBILIS Sowerby. ROMBLON; TABLAS.

Helix ignobilis SOWERBY, Proc. Zool. Soc. London (1840) 102; Conchol. Icon. 7 (1854) *Helix* pl. 15, fig. 57; Man. Conchol. II 7 (1891) 180, pl. 33, fig. 65; 9 (1894) 225; Obras Malacológicas (1890) 461, pl. 48, figs. 1–3; pl. 125, fig. 6.

HELICOSTYLA ILOCONENSIS Sowerby. ILOCOS PROVINCES.

Helix iloconensis SOWERBY, Proc. Zool. Soc. London (1840) 116, Conchol. Icon. 7 (1854) *Helix* pl. 25, figs. 109*a*–109*c*; Obras Malacológicas (1890) 490, pl. 84, figs. 4–6; pl. 96, figs. 7, 8; Man. Conchol. II 7 (1891) 175, pl. 39, figs. 97–100; 9 (1894) 226; Reisen Philippinen 3 (1870) 197, pl. 16, fig. 4; pl. 18, fig. 10.

HELICOSTYLA IMPERATOR Pfeiffer. TAYABAS; CATANDUANES.

Man. Conchol. II 7 (1891) 199, pl. 45, figs. 42–44; 9 (1894) 227; Obras Malacológicas (1890) 398, pl. 64, fig. 5; pl. 65, fig. 1; pl. 70, fig. 2; pl. 113, fig. 4; Abh. Naturf. Ges. 22 (1898) 116.

HELICOSTYLA INCOMPTA Sowerby. TABLAS.

Helix incompta SOWERBY, Proc. Zool. Soc. London (1840) 103; Man. Conchol. II 8 (1892) 28, pl. 10, fig. 6; 9 (1894) 229; Obras Malacológicas (1890) 528, pl. 117, fig. 2.

HELICOSTYLA INDUSIATA Pfeiffer. SARANGANI.

Obras Malacológicas (1890) 329, pl. 34, fig. 5; pl. 139, fig. 1.

HELICOSTYLA INFUSCATA Albers. PHILIPPINES (?).

Man. Conchol. II 7 (1891) 152, pl. 30, figs. 20, 21; 9 (1894) 223.

HELICOSTYLA INTERCEDENS Moellendorff. CAMARINES SUR.

Obras Malacológicas (1890) 392, pl. 67, fig. 1; Abh. Naturf. Ges. 22 (1898) 115; Nachrichbl. Malak. Ges. 27 (1895) 116.

HELICOSTYLA INTERMEDIA Quadras and Moellendorff. TAYABAS.

Obras Malacológicas (1890) 375; Nachrichbl. Malak. Ges. 28 (1896) 11.

HELICOSTYLA INTORTA Sowerby. VISAYAN ISLANDS; MINDANAO.

Helix intorta SOWERBY, Proc. Zool. Soc. London (1840) 168; Conchol. Icon. 7 (1854) *Helix* pl. 20, figs. 83*a*–83*f*; Obras Malacológicas (1890) 149, 206, pl. 22, fig. 9; pl. 131, fig. 5; Man. Conchol. II 7 (1891) 125, pl. 28, figs. 16–24; 9 (1894) 220.

HELICOSTYLA IROSINENSIS Hidalgo. ALBAY.

Helix irosinensis HIDALGO, Obras Malacológicas (1890) 26, 148, 204, pl. 25, fig. 9; Man. Conchol. II 7 (1891) 121, pl. 28, figs. 29, 30; 9 (1894) 220.

HELICOSTYLA JONASI Pfeiffer. BATANES; MINDORO; TABLAS.

Helix jonasi PFEIFFER, Proc. Zool. Soc. London (1845) 126; Conchol. Icon. 7 (1854) *Helix* pl. 26, fig. 113; Man. Conchol. II 8 (1892) 32, pl. 8, figs. 53, 54, 56, 57; pl. 17, fig. 32; 7 (1891) pl. 37, figs. 43, 44; 9 (1894) 229; Obras Malacológicas (1890) 482, pl. 103, figs. 1, 2; *Helix buschi* PFEIFFER, Proc. Zool. Soc. London (1845) 126; Conchol. Icon. 7 (1854) *Helix* pl. 203, fig. 1430; Obras Malacológicas (1890) 483, pl. 87, figs. 5, 6; pl. 103, fig. 4; pl. 117, figs. 4, 5; pl. 103, figs. 3–5; *Helix perdita* REEVE, Conchol. Icon. 7 (1854) *Helix* pl. 25, figs. 108*a*, 108*b*.

HELICOSTYLA JUGLANS Pfeiffer. LUZON.

Man. Conchol. II 7 (1891) 209, pl. 59, fig. 6; 9 (1894) 229; Obras Malacológicas (1890) 376, pl. 60, fig. 2; *Cochlostyla olivacea* MOELLENDORFF, Obras Malacológicas (1890) 377, pl. 69, fig. 3.

HELICOSTYLA KOBELTI Moellendorff. RIZAL.

Helix kobelti MOELLENDORFF, Obras Malacológicas (1890) 201, pl. 132, figs. 2, 3; Man. Conchol. II 7 (1891) 160; 9 (1894) 223.

HELICOSTYLA LACERA Pfeiffer. PHILIPPINES.

Helix lacera PFEIFFER, Proc. Zool. Soc. London (1853) 126; Conchol. Icon. 7 (1854) *Helix* pl. 182, fig. 1266; Man. Conchol. II 7 (1891) 189, pl. 59, figs. 1, 2; 9 (1894) 225; Obras Malacológicas (1890) 447, pl. 68, fig. 3.

HELICOSTYLA LACERATA Semper. CENTRAL MINDANAO.

Man. Conchol. II 8 (1892) 36, pl. 13, fig. 57; 9 (1894) 230; *Cochlostyla paradoxa* SEMPER, Reisen Philippinen 3 (1870) 217, pl. 9, fig. 5; Obras Malacológicas (1890) 419, pl. 125, figs. 2, 3.

HELICOSTYLA LALLOENSIS Pfeiffer. CAGAYAN.

Helix lalloensis PFEIFFER, Proc. Zool. Soc. London (1855) 111; Man. Conchol. II 7 (1891) 136, pl. 51, fig. 16; pl. 26, figs. 2, 3; 9 (1894) 222.

HELICOSTYLA LAMELLICOSTIS Moellendorff. CAMARINES NORTE.

Abh. Naturf. Ges. 22 (1898) 110.

HELICOSTYLA LANGUIDA Pfeiffer. SIQUIJOR.

Helix languida PFEIFFER, Proc. Zool. Soc. London (1842) 150; Conchol. Icon. 7 (1854) *Helix* pl. 17, fig. 68; Man. Conchol. II 7 (1891) 189, pl. 36, fig. 30; 9 (1894) 225.

HELICOSTYLA LEAI Pfeiffer. PHILIPPINES.

Man. Conchol. II 8 (1892) 32, pl. 17, figs. 33, 34; 9 (1894) 229. See *Helicostyla jonasi* Pfeiffer.

HELICOSTYLA LEOPARDUS Pfeiffer. MINDORO; MINDANAO.

Man. Conchol. II 8 (1892) 9, pl. 1, fig. 9; 9 (1894) 228; Obras Malacológicas (1890) 438, pl. 95, fig. 3; pl. 125, fig. 1; pl. 142, fig. 4.

HELICOSTYLA LEUCAUCHEN Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 115; Abh. Naturf. Ges. 22 (1898) 86.

HELICOSTYLA LEUCOPHÆA Sowerby. LUZON.

Helix leucophæa SOWERBY, Proc. Zool. Soc. London (1840) 18; Man. Conchol. II **8** (1892) 6, pl. 1, figs. 7, 8; **9** (1894) 228; Reisen Philippinen **3** (1870) 206, pl. 13, figs. 5*a*, *b*; pl. 18, fig. 20; Obras Malacológicas (1890) 433, No. 399, pl. 57, figs. 3, 4; pl. 85, fig. 7; pl. 123, fig. 3; pl. 95, fig. 8.

HELICOSTYLA LIBATA Reeve. MOUNTAIN PROVINCE.

Helix libata REEVE, Conchol. Icon. **7** (1854) *Helix* pl. 8, fig. 35; Man. Conchol. II **7** (1891) 157, pl. 56, figs. 61–63; **9** (1894) 223; Obras Malacológicas (1890) 451, pl. 34, fig. 7.

HELICOSTYLA LIBROSA Pfeiffer. PALAWAN.

Man. Conchol. II **8** (1892) 12; **9** (1894) 228. See *Helicostyla satyrus* Broderip.

HELICOSTYLA LIGNARIA Pfeiffer. CAGAYAN; ISABELA.

Man. Conchol. II **7** (1891) 204, pl. 62, fig. 30; pl. 41, figs. 10–13; **9** (1894) 227; Proc. U. S. Nat. Mus. **55** (1919) 301, pl. 18, fig. 4; Obras Malacológicas (1890) 386, pl. 69, figs. 4, 5; pl. 78, fig. 1; Abh. Naturf. Ges. **22** (1898) 112.

HELICOSTYLA LIGNICOLOR Moellendorff. SURIGAO.

Man. Conchol. II **7** (1891) 153; **9** (1894) 223.

HELICOSTYLA LIMANSAUENSIS Semper. LIMANSAUA, LEYTE.

Helix limansauensis SEMPER, Obras Malacológicas (1890) 285, 149, 206, pl. 21, fig. 7; pl. 87, figs. 1–3; Man. Conchol. II **7** (1891) 126, pl. 28, figs. 25, 26; **9** (1894) 220; Reisen Philippinen **3** (1870) 171, pl. 9, figs. 6*a*, *b*.

HELICOSTYLA LIVIDOCINCTA Semper. NORTHERN TAYABAS.

Helix lividocincta SEMPER, Obras Malacológicas (1890) 214, 165, pl. 130, figs. 4–6; Man. Conchol. II **7** (1891) 171, pl. 56, figs. 71, 72,; **9** (1894) 221; Reisen Philippinen **3** (1870) 182, pl. 9, fig. 9.

HELICOSTYLA LOHERI Moellendorff. BATAAN.

Man. Conchol. II **9** (1894) 220; Nachrichbl. Malak. Ges. **26** (1894) 106.

HELICOSTYLA LUENGOI Hidalgo. CAMARINES SUR.

Man. Conchol. II **8** (1892) 245; **7** (1891) pl. 61, fig. 21; **9** (1894) 223; Obras Malacológicas (1890) 49, 300, pl. 104, fig. 2.

HELICOSTYLA LUZONICA Sowerby. LUZON.

Helix luzonica SOWERBY, Proc. Zool. Soc. London (1842) 85; Conchol. Icon. **7** (1854) *Helix* pl. 10, fig. 41; Reisen Philippinen **3** (1870) 185, pl. 8, fig. 1; Obras Malacológicas (1890) 307, pl. 29, figs. 3–5; pl. 132, fig. 1; Abh. Naturf. Ges. **22** (1898) 83; Proc. U. S. Nat. Mus. **55** (1919) 303, pl. 18, figs. 1–3. See *Helicostyla festiva* Donovan.

HELICOSTYLA MACROSTOMA Pfeiffer. BATAAN.

Man. Conchol. II **7** (1891) 208, pl. 61, fig. 20; **9** (1894) 227; Obras Malacológicas (1890) 371, pl. 41, fig. 4; pl. 68, fig. 1; pl. 69, fig. 1; Proc. U. S. Nat. Mus. **55** (1919) 302, pl. 18, fig. 6.

HELICOSTYLA MAGISTRA Pfeiffer. CEBU; LEYTE.

Helix magister PFEIFFER, Conchol. Icon. 7 (1854) *Helix* pl. 155, fig. 1018; Obras Malacológicas (1890) 145, 202, pl. 11, fig. 3; Man. Conchol. II 7 (1891) 164, pl. 41, figs. 17–19; pl. 57, fig. 76; pl. 21, figs. 37, 38; 9 (1894) 224; *Cochlostyla gloynei* SOWERBY, Abh. Naturf. Ges. 22 (1898) 93; Obras Malacológicas (1890) 144, 202, pl. 11, figs. 1, 2.

HELICOSTYLA MAGTANENSIS Semper. MACTAN ISLAND, CEBU.

Reisen Philippinen 3 (1870) 170, pl. 10, figs. 11*a*, *b*. See *Helicostyla zamboanga* Hombron and Jacquinot.

HELICOSTYLA MAINITENSIS Hidalgo. SURIGAO.

Man. Conchol. II 7 (1891) 152, pl. 55, fig. 56; 9 (1894) 223; Obras Malacológicas (1890) 49.

HELICOSTYLA MARINDUQUENSIS Hidalgo. MARINDUQUE; ROMBLON.

Man. Conchol. II 7 (1891) 209, pl. 45, figs. 48, 49; 9 (1894) 229; Obras Malacológicas (1890) 29, 379, pl. 64, figs. 1–4.

HELICOSTYLA MARTENSI Moellendorff. BENGUET.

Abh. Naturf. Ges. 22 (1898) 98.

HELICOSTYLA MATRUELIS Sowerby. MISAMIS.

Helix matruelis SOWERBY, Proc. Zool. Soc. London (1841) 24; Conchol. Icon. 7 (1854) *Helix* pl. 18, figs. 75*a*, 75*b*; Man. Conchol. II 7 (1891) 151, pl. 48, figs. 70, 71; 9 (1894) 223; Obras Malacológicas (1890) 328, pl. 34, fig. 6.

HELICOSTYLA MEARNSI Bartsch. MOUNT APO, MINDANAO.

Smithsonian Misc. Coll. 47 (1905) 409, pl. 56.

HELICOSTYLA MELANOCHILA Valenciennes. MINDORO.

Helix melanocheila VALENCIENNES, Conchol. Icon. 7 (1854) *Helix* pl. 19, figs. 80*a*, 80*b*; Man. Conchol. II 7 (1891) 150, pl. 30, figs. 17–19; 9 (1894) 223; Obras Malacológicas (1890) 287, pl. 40, figs. 2, 3; *Helix brunnea* SOWERBY, Proc. Zool. Soc. London (1841) 40.

HELICOSTYLA MELANORHAPHE Quadras and Moellendorff. ISABELA.

Obras Malacológicas (1890) 452, pl. 124, figs. 1, 2; pl. 132, fig. 7; Nachrichbl. Malak. Ges. 28 (1896) 10.

HELICOSTYLA METAFORMIS Férussac. LUZON; BOHOL.

Helix metaformis FÉRUSSAC, Proc. Zool. Soc. London (1840) 17; Conchol. Icon. 7 (1854) *Helix* pl. 17, figs. 70*a*, 70*b*; Man. Conchol. II 7 (1891) 186, pl. 36, figs. 25–29; 9 (1894) 225; Obras Malacológicas (1890) 430, pl. 36, fig. 4; pl. 55, figs. 3–6; pl. 77, figs. 2–4; pl. 108, figs. 6, 7; Reisen Philippinen 3 (1870) 192, pl. 13, fig. 16; pl. 18, fig. 21.

HELICOSTYLA METALLORUM Moellendorff. CAMARINES SUR.

Obras Malacológicas (1890) 291; Abh. Naturf. Ges. 22 (1898) 85.

HELICOSTYLA MICANS Pfeiffer. CAGAYAN.

Helix micans PFEIFFER, Proc. Zool. Soc. London (1845) 71; Conchol. Icon. 7 (1854) *Helix* pl. 13, fig. 46*a*; Obras Malacológicas (1890) 215, 166, pl. 130, fig. 1; Man. Conchol. II 7 (1891) 128, pl. 19, figs. 12–14; 9 (1894) 221.

HELICOSTYLA MICROSPIRA Pfeiffer. PHILIPPINES.

Helix microspira PFEIFFER, Proc. Zool. Soc. London (1853) 127; Conchol. Icon. 7 (1854) *Helix* pl. 183, figs. 1268*a*, 1268*b*; Man. Conchol. II 7 (1891) 145, pl. 53, figs. 34–36; 9 (1894) 222; Obras Malacológicas (1890) 294, pl. 96, fig. 6; pl. 118, fig. 6.

HELICOSTYLA MINDANAENSIS Sowerby. MINDANAO.

Helix mindanaensis SOWERBY, Proc. Zool. Soc. London (1842) 85; Conchol. Icon. 7 (1854) *Helix* pl. 7, fig. 32; Man. Conchol. II 7 (1891) 148, pl. 47, figs. 61, 62; 9 (1894) 223; Obras Malacológicas (1890) 362, pl. 84, figs. 2, 3.

HELICOSTYLA MINDOROENSIS Broderip. MINDORO.

Man. Conchol. II 8 (1892) 52, pl. 14, figs. 68–71; pl. 15, figs. 1, 2; 9 (1894) 231; Obras Malacológicas (1890) 548, pl. 97, figs. 3–5; pl. 142, fig. 5.

HELICOSTYLA MIRABILIS Férussac. LUZON; MINDORO; MARINDUQUE.

Helix mirabilis FÉRUSSAC, Proc. Zool. Soc. London (1841) 2; Conchol. Icon. 7 (1854) *Helix* pl. 12, figs. 45*a*–45*g*; *Helix fulgens* SOWERBY, Proc. Zool. Soc. London (1841) 3; Conchol. Icon. 7 (1854) *Helix* pl. 7, figs. 31*a*, 31*b*; Obras Malacológicas (1890) 453, pl. 36, fig. 5; pl. 50, figs. 4, 5; pl. 95, fig. 1; pl. 109, fig. 6; pl. 132, fig. 6; Man. Conchol. II 7 (1891) 181, pl. 57, figs. 79–86; pl. 31, fig. 40; 9 (1894) 224; Obras Malacológicas (1890) 441, pl. 43, figs. 3–6; pl. 49, figs. 1–7; pl. 50, figs. 7, 8; pl. 139, fig. 3; Proc. Biol. Soc. Wash. 31 (1918) 153.

HELICOSTYLA MODESTA Sowerby. LUZON.

Helix modesta SOWERBY, Proc. Zool. Soc. London (1841) 39; Man. Conchol. II 8 (1892) 35, pl. 17, figs. 28–30; 9 (1894) 230; Obras Malacológicas (1890) 520, pl. 106, figs. 5–7; pl. 73, fig. 1.

HELICOSTYLA MONTANA Semper. MOUNTAIN PROVINCE.

Man. Conchol. II 7 (1891) 191, pl. 58, figs. 93, 94; 9 (1894) 225; Reisen Philippinen 3 (1870) 194, pl. 9, fig. 4; Obras Malacológicas (1890) 437, pl. 113, figs. 7, 8; pl. 123, fig. 4.

HELICOSTYLA MONTFORTIANA Pfeiffer. TABLAS.

Helix montfortiana PFEIFFER, Proc. Zool. Soc. London (1846) 38; Conchol. Icon. 7 (1854) *Helix* pl. 18, fig. 76; Obras Malacológicas (1890) 146, 477, 202, pl. 83, figs. 5, 6; Man. Conchol. II 7 (1891) 165, pl. 41, figs. 14–16; 9 (1894) 224.

HELICOSTYLA MONTICULA Sowerby. NORTHERN LUZON.

Helix monticula SOWERBY, Proc. Zool. Soc. London (1840) 167; Conchol. Icon. 7 (1854) *Helix* pl. 24, figs. 103*a*–103*c*; Man. Conchol. II 7 (1891) 176, pl. 39, figs. 94–96; 9 (1894) 225; Reisen Philippinen 3 (1870) 196, pl. 8, fig. 6; pl. 13, fig. 1; pl. 18, fig. 23; Obras Malacológicas (1890) 496, pl. 42, figs. 1–3.

HELICOSTYLA MORELETI Pfeiffer. CEBU.

Helix moreleti PFEIFFER, Obras Malacológicas (1890) 145, 202, pl. 114, fig. 6; Man. Conchol. II 7 (1891) 165, pl. 45, figs. 45, 46; 9 (1894) 224.

HELICOSTYLA MUS Broderip. MOUNTAIN PROVINCE.

Man. Conchol. II **8** (1892) 6, pl. 1, figs. 1, 2; **9** (1894) 228; Obras Malacológicas (1890) 428, pl. 90, figs. 4, 5; pl. 95, figs. 5–7.

HELICOSTYLA NIGROCINCTA Semper. MINDORO.

Man. Conchol. II **8** (1892) 50, pl. 13, fig. 62; **9** (1894) 231; Obras Malacológicas (1890) 508, pl. 113, figs. 1, 2; pl. 120, figs. 7, 8.

HELICOSTYLA NIMBOSA Broderip. NEGROS; PANAY.

Man. Conchol. II **8** (1892) 21, pl. 4, figs. 36, 37; **9** (1894) 228; Obras Malacológicas (1890) 399, pl. 106, figs. 2, 3; pl. 123, fig. 2; pl. 119, fig. 6; Proc. Biol. Soc. Wash. **32** (1919) 17.

HELICOSTYLA NORRISII Sowerby. LUZON; LEYTE; MINDANAO.

Helix norrisii SOWERBY, Proc. Zool. Soc. London (1842) 85; Conchol. Icon. **7** (1854) *Helix* pl. 5, fig. 21; Man. Conchol. II **7** (1891) 143, pl. 31, figs. 41, 42; **9** (1894) 223; Obras Malacológicas (1890) 325, pl. 30, figs. 1, 2.

HELICOSTYLA NUX Semper. NORTHEASTERN LUZON.

Man. Conchol. II **8** (1892) 5; **7** (1891) pl. 36, fig. 34; **9** (1894) 228; *Cochlostyla nux* SEMPER, Reisen Philippinen **3** (1870) 204, pl. 10, fig. 2; Obras Malacológicas (1890) 448, pl. 68, fig. 2; pl. 116, fig. 3.

HELICOSTYLA OBTUSA Pfeiffer. LUZON.

Helix obtusa PFEIFFER, Proc. Zool. Soc. London (1845) 38; Conchol. Icon. **7** (1854) *Helix* pl. 14, fig. 9; Man. Conchol. II **7** (1891) 132, pl. 35, figs. 23, 24; **9** (1894) 222; Obras Malacológicas (1890) 476, pl. 108, fig. 4; pl. 114, fig. 5; pl. 124, fig. 5.

HELICOSTYLA OLANIVANENSIS Bartsch. OLANIVAN ISLAND, SARANGANI GROUP.

Proc. U. S. Nat. Mus. **45** (1913) 551; pl. 43, figs. 4–8, 11.

HELICOSTYLA OPALINA Sowerby. BATANES; CAGAYAN.

Helix opalinus SOWERBY, Proc. Zool. Soc. London (1840) 98; Conchol. Icon. **7** (1854) *Helix* pl. 23, fig. 97; Man. Conchol. II **8** (1892) 42, pl. 8, figs. 50, 51; **9** (1894) 230; Reisen Philippinen **3** (1870) 212, pl. 13, fig. 8; Obras Malacológicas (1890) 489, pl. 81, fig. 1.

HELICOSTYLA ORBITULA Sowerby. MINDORO.

Helix orbitulus SOWERBY, Proc. Zool. Soc. London (1840) 103; Conchol. Icon. **7** (1854) *Helix* pl. 15, figs. 60*a*, 60*b*; Man. Conchol. II **7** (1891) 179, pl. 58, figs. 98, 99; **9** (1894) 225; Obras Malacológicas (1890) 459, pl. 38, figs. 6, 7; pl. 95, fig. 2.

HELICOSTYLA OVIFORMIS Semper. MINDANAO.

Man. Conchol. II **8** (1892) 40, pl. 8, fig. 55; **9** (1894) 230; Reisen Philippinen **3** (1870) 218, pl. 10, fig. 6; Obras Malacológicas (1890) 422, pl. 116, fig. 6.

HELICOSTYLA OVOIDEA Bruguière. LUZON; TICAO; MASBATE.

Man. Conchol. II **8** (1892) 43, pl. 5, figs. 10–16; **9** (1894) 230; Obras Malacológicas (1890) 499, pl. 72, figs. 1–9; pl. 73, figs. 5–7; Abh. Naturf. Ges. **22** (1898) 102, *Cochlostyla costerii* EYDOUX, 102.

HELICOSTYLA PALAWANENSIS Pfeiffer. PALAWAN.

Proc. Biol. Soc. Washington **32** (1919) 179–181.

HELICOSTYLA PAN Broderip. BOHOL; PANGLAO.

Helix pan BRODERIP, Conchol. Icon. **7** (1854) *Helix* pl. 5, figs. 24*a*–24*c*; Man. Conchol. II **7** (1891) 149, pl. 33, figs. 55–57; **9** (1894) 223; Obras Malacológicas (1890) 340, pl. 30, figs. 5, 6; pl. 122, fig. 8; pl. 124, figs. 3, 4.

HELICOSTYLA PANAENSIS Semper. PANAON.

Man. Conchol. II **7** (1891) 168; **9** (1894) 224; Reisen Philippinen **3** (1870) 189. See *Helicostyla cryptica* Broderip.

HELICOSTYLA PAPYRACEA Broderip. MINDORO; CEBU.

Helix papyracea BRODERIP, Proc. Zool. Soc. London (1840) 36; Conchol. Icon. **7** (1854) *Helix* pl. 22, fig. 90; Obras Malacológicas (1890) 147, 204, pl. 21, figs. 1, 2; Man. Conchol. II **7** (1891) 117, pl. 24, figs. 34–36; **9** (1894) 219.

HELICOSTYLA PARTULOIDES Broderip. TABLAS; MINDORO.

Man. Conchol. II **8** (1892) 50, pl. 16, figs. 20–24; **9** (1894) 231; Obras Malacológicas (1890) 507, pl. 98, figs. 2, 3.

HELICOSTYLA PATRICIA Pfeiffer. TAYABAS.

Helix patricia PFEIFFER, Obras Malacológicas (1890) 146, 203, pl. 21, fig. 6; Abh. Naturf. Ges. **22** (1898) 94.

HELICOSTYLA PERAFFINIS Pilsbry. PHILIPPINES.

Man. Conchol. II **7** (1891) 139, pl. 54, figs. 47, 48; **9** (1894) 222. See *Helicostyla polillensis* Pfeiffer.

HELICOSTYLA PFEIFFERI Semper. CEBU.

Man. Conchol. II **7** (1891) 162, pl. 44, figs. 34–37; **9** (1894) 224; *Cochlostyla pfeifferi* SEMPER, Reisen Philippinen **3** (1870) 191; *Helix cumingii* PFEIFFER, Proc. Zool. Soc. London (1842) 88; Conchol. Icon. **7** (1854) *Helix* pl. 14, fig. 51; Obras Malacológicas (1890) 144, 202, pl. 11, figs. 6, 7.

HELICOSTYLA PHÆOSTYLA Pfeiffer. PHILIPPINES.

Man. Conchol. II **8** (1892) 41, pl. 5, fig. 4; pl. 9, figs. 64–66; **9** (1894) 230; Obras Malacológicas (1890) 420, pl. 59, figs. 7, 8; pl. 103, fig. 6.

HELICOSTYLA PHLOIODES Pfeiffer. CEBU.

Helix phloiodes PFEIFFER, Proc. Zool. Soc. London (1842) 151; Conchol. Icon. **7** (1854) *Helix* pl. 14, figs. 55*a*, 55*b*; Man. Conchol. II **7** (1891) 163, pl. 40, figs. 8, 9; **9** (1894) 224; Obras Malacológicas (1890) 146, 203, pl. 144, fig. 9.

HELICOSTYLA PICTOR Broderip. PANAY; NEGROS; MASBATE.

Man. Conchol. II **8** (1892) 8, pl. 4, figs. 38–41; **9** (1894) 228; Obras Malacológicas (1890) 405, pl. 76, figs. 2–4; pl. 78, fig. 2; pl. 110, fig. 6.

HELICOSTYLA PILSBRYI Hidalgo. CEBU.

Obras Malacológicas (1890) 396, pl. 95, fig. 4; pl. 117, fig. 3. See *Helicostyla cunetatus* Reeve.

HELICOSTYLA PITHOGASTER Férussac. LUZON; MASBATE.

Man. Conchol. II 7 (1891) 200, pl. 40, figs. 2–5; 9 (1894) 227; Reisen Philippinen 3 (1870) 201, pl. 13, fig. 12; Obras Malacológicas (1890) 390, pl. 67, figs. 1–5; pl. 104, fig. 4; pl. 142, fig. 8; *Cochlostyla philippinensis* PFEIFFER, 392, pls. 76, 77, fig. 1; pl. 92, figs. 1, 2; pl. 142, fig. 7; pl. 39, fig. 1.

HELICOSTYLA PLURIZONATA Adams and Reeve. MINDANAO.

Man. Conchol. II 7 (1891) 183, pl. 59, figs. 4, 5; 9 (1894) 224.

HELICOSTYLA POLILLENSIS Pfeiffer. POLILLO.

Helix polillensis PFEIFFER, Proc. Zool. Soc. London (1861) 190; *Helix ajax* PFEIFFER, 191; *Helix hector* PFEIFFER, 191; Man. Conchol. II 7 (1891) 138, pl. 32, figs. 43–50; 9 (1894) 222; Obras Malacológicas (1890) 301, pl. 46, fig. 6; pl. 87, figs. 7, 8; pl. 111, fig. 6; pl. 126, pl. 6.

HELICOSTYLA PONDEROSA Pfeiffer. ILOCOS PROVINCES.

Helix ponderosa PFEIFFER, Proc. Zool. Soc. London (1845) 38; Conchol. Icon. 7 (1854) *Helix* pl. 13, fig. 47; Man. Conchol. II 7 (1891) 147; pl. 48, fig. 65; 9 (1894) 222; Obras Malacológicas (1890) 338, pl. 118, fig. 5.

HELICOSTYLA PORTEI Pfeiffer. POLILLO; LAGUNA.

Helix portii PFEIFFER, Proc. Zool. Soc. London (1861) 191; Man. Conchol. II 7 (1891) 206, pl. 44, figs. 38, 39; 9 (1894) 227; Obras Malacológicas (1890) 368, pl. 62, fig. 3; pl. 63, fig. 1.

HELICOSTYLA PRINCEPS Reeve. PHILIPPINES.

Man. Conchol. II 7 (1891) 137, pl. 33; figs. 58, 59; 9 (1894) 222.

HELICOSTYLA PROPITIA Fulton. CEBU.

Ann. & Mag. Nat. Hist. XIX 7 (1907) 150, pl. 9, figs. 4–6.

HELICOSTYLA PSITTACINA Deshayes. NORTHERN LUZON.

Helix psittacina DESHAYES, Obras Malacológicas (1890) 153, 208, pl. 143, figs. 2, 3; Man. Conchol. II 7 (1891) 118, pl. 25, figs. 49–51; 9 (1894) 219.

HELICOSTYLA PUDIBUNDA Semper. NORTHERN LUZON.

Man. Conchol. II 7 (1891) 171; 9 (1894) 221; Reisen Philippinen 3 (1870) 183; Obras Malacológicas (1890) 282, pl. 146, figs. 1–3.

HELICOSTYLA PUELLA Broderip. CAMIGUING; MINDANAO; BASILAN.

Helix puella BRODERIP, Proc. Zool. Soc. London (1841) 45; Conchol. Icon. 7 (1854) *Helix* pl. 21, fig. 66; Obras Malacológicas (1890) 148, 205, pl. 21, fig. 4; Man. Conchol. II 7 (1891) 120, pl. 24, figs. 22, 23, 25; pl. 25, fig. 39; 9 (1894) 220; Reisen Philippinen 3 (1870) 167; *Helix lais* PFEIFFER, Proc. Zool. Soc. London (1853) 49; Conchol. Icon. 7 (1854) *Helix* pl. 155, fig. 1016; Obras Malacológicas (1890) 148, 205, pl. 21, fig. 5.

HELICOSTYLA PULCHELLA Moellendorff. LUZON.

Man. Conchol. II 9 (1894) 225; Obras Malacológicas (1890) 497, pl. 108, fig. 5; Nachrichbl. Malak. Ges. 25 (1893) 176.

HELICOSTYLA PULCHERRIMA Sowerby. LUZON.

Helix pulcherrima SOWERBY, Proc. Zool. Soc. London (1840) 90; Conchol. Icon. 7 (1854) *Helix* pl. 6, figs. 26*a*–26*k*; Man. Conchol. II 7 (1891) 133, pl. 33, figs. 60–64; 9 (1894) 222; Reisen Philippinen 3 (1870) 174, pl. 13, fig. 9; pl. 18, fig. 16; Obras Malacológicas (1890) 309, pl. 29, fig. 6; pl. 33, figs. 2–7; pl. 36, fig. 3; pl. 108, figs. 1–3; pl. 121, fig. 6; pl. 141, fig. 2.

HELICOSTYLA PYRAMIDALIS Sowerby. CUYO.

Helix pyramidalis SOWERBY, Proc. Zool. Soc. London (1841) 39; Man. Conchol. II 8 (1892) 28, pl. 9, figs. 61, 62; 9 (1894) 229; Obras Malacológicas (1890) 527, pl. 105, fig. 6.

HELICOSTYLA QUADRASI Hidalgo. MARINDUQUE.

Man. Conchol. II 8 (1892) 34, pl. 5, figs. 5–7; 9 (1894) 230; Obras Malacológicas (1890) 15, 522, pl. 105, figs. 7, 8; pl. 156, figs. 1–4.

HELICOSTYLA QUADRIFASCIATA Hidalgo. PHILIPPINES.

Obras Malacológicas (1890) 534, pl. 106, fig. 8; Abh. Naturf. Ges. 22 (1898) 104.

HELICOSTYLA REGINÆ Broderip. LUZON; CEBU; MINDORO.

Helix reginæ BRODERIP, Proc. Zool. Soc. London (1840) 36; Conchol. Icon. 7 (1854) *Helix* pl. 29, figs. 125*a*, 125*b*; Obras Malacológicas (1890) 153, 209, pl. 24, figs. 3, 4; pl. 144, figs. 1, 2; Man. Conchol. II 7 (1891) 116, pl. 25, figs. 45, 46; 9 (1894) 219.

HELICOSTYLA REHBEINI Pfeiffer. PHILIPPINES.

Helix rehbeini PFEIFFER, Proc. Zool. Soc. London (1852) 84; Conchol. Icon. 7 (1854) *Helix* pl. 115, fig. 663; Man. Conchol. II 7 (1891) 190, pl. 37, figs. 45, 46; 9 (1894) 225; Obras Malacológicas (1890) 460, pl. 114 figs. 3, 4.

HELICOSTYLA RETUSA Pfeiffer. SAMAR.

Helix retusa PFEIFFER, Proc. Zool. Soc. London (1845) 132; Conchol. Icon. 7 (1854) *Helix* pl. 20, fig. 82; Man. Conchol. II 7 (1891) 157, pl. 56, figs. 59, 60; 9 (1894) 223; Obras Malacológicas (1890) 335, pl. 107, figs. 5–7.

HELICOSTYLA ROEBELENI Moellendorff. NUEVA ECIJA.

Man. Conchol. II 9 (1894) 225; Obras Malacológicas (1890) 346, pl. 52, fig. 1; Nachrichbl. Malak. Ges. 26 (1894) 98.

HELICOSTYLA ROISSYANA Férussac. MINDORO.

Helix roissyana FÉRUSSAC, Proc. Zool. Soc. London (1840) 101; Conchol. Icon. 7 (1854) *Helix* pl. 18, figs. 73*a*–73*c*; Man. Conchol. II 7 (1891) 151, pl. 30, figs. 23–28; 9 (1894) 223; Obras Malacológicas (1890) 463, pl. 35, fig. 3; pl. 51, figs. 1–7; pl. 122, figs. 2–4; pl. 50, fig. 3; *Helix solida* PFEIFFER, Proc. Zool. Soc. London (1851) 263; Man. Conchol. II 7 (1891) 153, pl. 30, fig. 22; 9 (1894) 223; Obras Malacológicas (1890) 374, pl. 93, fig. 1; pl. 106, fig. 4; pl. 117, fig. 6.

HELICOSTYLA ROLLEI Moellendorff. MINDORO.

Obras Malacológicas (1890) 546, pl. 127, figs. 1, 2; Abh. Naturf. Ges. 22 (1898) 121.

HELICOSTYLA RUFOGASTER Lesson. CENTRAL LUZON.

Man. Conchol. II 7 (1891) 207, pl. 43, figs. 26, 27; pl. 45, fig. 47; 9 (1894) 227; Obras Malacológicas (1890) 372, pl. 61, figs. 1–5; pl. 104, fig. 5.

HELICOSTYLA RUSTICA Mousson. NUEVA ECIJA; BULACAN.

Obras Malacológicas (1890) 426, pl. 91, figs. 1–5.

HELICOSTYLA SAMARENSIS Semper. SAMAR; SIBUYAN.

Man. Conchol. II 7 (1891) 146, pl. 34, figs. 1, 2; pl. 54, figs. 41, 42; 9 (1894) 222; Reisen Philippinen 3 (1870) 179, pl. 10, figs. 5, 9; pl. 13, fig. 15; pl. 18, fig. 12; Obras Malacológicas (1890) 290, pl. 96, fig. 5; pl. 111, fig. 1.

HELICOSTYLA SAMBOANGA Hombron and Jacquinot. MINDANAO; CEBU; BASILAN; BALABAC.

Helix samboanga HOMBRON and JACQUINOT, Voy. Astrolabe et Zélee (1854) 15, pl. 5, figs. 18–20; Obras Malacológicas (1890) 151, 206, pl. 22, figs. 2, 3; Man. Conchol. II 7 (1891) 124, pl. 26, figs. 13–15; 9 (1844) 219.

HELICOSTYLA SARANGANICA Moellendorff. SARANGANI.

Nachrichbl. Malak. Ges. 22 (1890) 204; Abh. Naturf. Ges. 22 (1898) 90.

HELICOSTYLA SARCINOSA Férussac. VISAYAN ISLANDS.

Helix sarcinosa FÉRUSSAC, Proc. Zool. Soc. London (1840) 121; Conchol. Icon. 7 (1854) *Helix* pl. 2, figs. 5*a*, 5*b*; Man. Conchol. II 7 (1891) 195, pl. 47, fig. 58; 9 (1894) 227; Obras Malacológicas (1890) 358, pl. 47, fig. 1; Abh. Naturf. Ges. 22 (1898) 111; *Cochlostyla turgens* DESHAYES, 360, pl. 46, figs. 1, 2; pl. 90, fig. 1; pl. 115, fig. 3; pl. 125, fig. 4.

HELICOSTYLA SATYRUS Broderip. TABLAS; PALAWAN.

Helix satyrus BRODERIP, Proc. Zool. Soc. London (1840) 181; Man. Conchol. II 8 (1892) 13, pl. 2, figs. 13–18; pl. 1, figs. 5, 6; 9 (1894) 228; Obras Malacológicas (1890) 423, pl. 63, fig. 5; pl. 54, figs. 2, 3; pl. 113, fig. 5; Ann. & Mag. Nat. Hist. XI 6 (1893) 350.

HELICOSTYLA SCHADENBERGI Moellendorff. NUEVA VIZCAYA.

Man. Conchol. II 7 (1891) 160; 9 (1894) 224; Proc. U. S. Nat. Mus. 55 (1919) 304, pl. 19, figs. 1–3; *Helix schadenbergi*, MOELLENDORFF, Obras Malacológicas (1890) 200, pl. 137, figs. 1, 2.

HELICOSTYLA SECKENDORFFIANA Pfeiffer. TABLAS.

Man. Conchol. II 8 (1892) 7; 7 (1891) pl. 37, fig. 49; 9 (1894) 228; Obras Malacológicas (1890) 480, pl. 109, fig. 7.

HELICOSTYLA SEMPERI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 175; Abh. Naturf. Ges. 22 (1898) 85.

HELICOSTYLA SIMPLEX Jonas. MINDORO.

Man. Conchol. II 8 (1892) 33, pl. 8, figs. 48, 49, 52; 9 (1894) 229; Obras Malacológicas (1890) 523, pl. 73, fig. 2.

HELICOSTYLA SIQUIJORENSIS Broderip. SIQUIJOR.

Helix siquijorensis BRODERIP, Proc. Zool. Soc. London (1840) 38; Conchol. Icon. 7 (1854) *Helix* pl. 27, fig. 119; Man. Conchol. II 7 (1891) 159, pl. 20, figs. 8–10; 9 (1894) 223; Obras Malacológicas (1890) 143, 200, pl. 12, figs. 2, 3.

HELICOSTYLA SMARAGDINA Reeve. EASTERN MINDANAO.

Man. Conchol. II 8 (1892) 37, pl. 2, figs. 19–22; 9 (1894) 229; Reisen Philippinen 3 (1870) 213, pl. 13, fig. 19; Obras Malacológicas (1890) 414, pl. 54, figs. 4, 5; pl. 58, figs. 1–5; pl. 76, fig. 5; pl. 120, fig. 1; pl. 159, fig. 3.

HELICOSTYLA SOLAI Hidalgo. NUEVA ECIJA; BULACAN.

Obras Malacológicas (1890) 378, pl. 55, figs. 4, 5; pl. 85, fig. 2. See *Helicostyla juglans* Pfeiffer var. *roseolimbata* Moellendorff.

HELICOSTYLA SOLIDA Pfeiffer. LUZON.

Man. Conchol. II 8 (1892) 8, pl. 9, fig. 60; 9 (1894) 228.

HELICOSTYLA SOLIVAGA Reeve. PHILIPPINES.

Man. Conchol. II 8 (1892) 9, pl. 3, fig. 30; 9 (1894) 228; Obras Malacológicas (1890) 404, pl. 86, fig. 7; pl. 119, fig. 8.

HELICOSTYLA SOWERBYI Hidalgo. CAPUL.

Obras Malacológicas (1890) 336, pl. 121, fig. 5.

HELICOSTYLA SPHÆRICA Sowerby. ILOCOS PROVINCES.

Helix sphærica SOWERBY, Proc. Zool. Soc. London (1841) 26; Conchol. Icon. 7 (1854) *Helix* pl. 24, figs. 104*a*–104*d*; Man. Conchol. II 7 (1891) 172, pl. 39, figs. 82, 84; 9 (1894) 226; Obras Malacológicas (1890) 467, pl. 34, figs. 3, 4; pl. 122, fig. 6.

HELICOSTYLA SPHAERION Sowerby. LEYTE; MINDANAO.

Helix sphaerion SOWERBY, Proc. Zool. Soc. London (1841) 2; Conchol. Icon. 7 (1854) *Helix* pl. 26, figs. 111*a*, 111*b*, 114; Man. Conchol. II 7 (1891) 154, pl. 31, figs. 34, 35; 9 (1894) 220; Reisen Philippinen 3 (1870) 184, 185; Obras Malacológicas (1890) 291, pl. 37, figs. 1–5.

HELICOSTYLA STABILIS Sowerby. BURIAS.

Helix stabilis SOWERBY, Proc. Zool. Soc. London (1840) 104; Man. Conchol. II 8 (1892) 45, pl. 6, figs. 25–28; 9 (1894) 231; Reisen Philippinen 3 (1870) 219, pl. 13, fig. 7; pl. 18, fig. 5; Obras Malacológicas (1890) 498, pl. 73, figs. 8, 9; pl. 120, fig. 3.

HELICOSTYLA STRAMINEA Semper. EASTERN MINDANAO.

Man. Conchol. II 8 (1892) 39, pl. 17, fig. 31; 9 (1894) 230; Reisen Philippinen 3 (1870) 216, pl. 8, fig. 10; Obras Malacológicas (1890) 418, pl. 80, figs. 5–6.

HELICOSTYLA STREPTOSTOMA Moellendorff. LUZON.

Obras Malacológicas (1890) 475, pl. 139, fig. 2; Nachrichbl. Malak. Ges. 25 (1893) 176.

HELICOSTYLA STRIATISSIMA Pilsbry. CEBU.

Man. Conchol. II 7 (1891) 162, pl. 57, figs. 73–75; pl. 20, fig. 7; 9 (1894) 223. See *Helicostyla zebuensis* Broderip.

HELICOSTYLA STRIGATA Quadras and Moellendorff. LUZON; ROMBLON.

Man. Conchol. II **9** (1894) 225; Nachrichbl. Malak. Ges. **26** (1894) 97.

HELICOSTYLA SUBCARINATA Pfeiffer. ROMBLON; MARINDUQUE.

Cochlostyla möllendorffi HIDALGO, Obras Malacológicas (1890) 35; Man. Conchol. II **8** (1892) 19, pl. 9, fig. 59; pl. 11, figs. 16–18; **9** (1894) 228; Abh. Naturf. Ges. **22** (1898) 108.

HELICOSTYLA SUBGLOBOSA Lea. CAMARINES NORTE.

Obras Malacológicas (1890) 384, pl. 112, fig. 1; Abh. Naturf. Ges. **22** (1898) 115.

HELICOSTYLA SUCCINCTA Reeve. BURIAS.

Man. Conchol. II **8** (1892) 17, pl. 10, fig. 14; **9** (1894) 228; Obras Malacológicas (1890) 534, pl. 71, figs. 7, 8; pl. 119, fig. 3.

HELICOSTYLA SUPRABADIA Semper. ISABELA.

Man. Conchol. II **8** (1892) 246, pl. 17, figs. 26, 27; **9** (1894) 224; Obras Malacológicas (1890) 354, pl. 87, fig. 4; Reisen Philippinen **3** (1870) 201, pl. 9, figs. 7*a*, *b*.

HELICOSTYLA TENERA Sowerby. MINDORO; TABLAS.

Helix tenera SOWERBY, Proc. Zool. Soc. London (1840) 102; Conchol. Icon. **7** (1854) *Helix* pl. 16, figs. 62*a*–62*c*; Man. Conchol. II **7** (1891) 179, pl. 36, figs. 31, 32; **9** (1894) 225; Obras Malacológicas (1890) 462, pl. 38, figs. 4, 5; pl. 50, figs. 1, 2; pl. 53, fig. 3; pl. 118, fig. 4.

HELICOSTYLA TEPHRODES Pfeiffer. PANGASINAN.

Helix tephrodes PFEIFFER, Proc. Zool. Soc. London (1842) 151; Conchol. Icon. **7** (1854) *Helix* pl. 26, fig. 112; Man. Conchol. II **7** (1891) 183, pl. 31, fig. 39; 9 (1894) 224; Obras Malacológicas (1890) 306, pl. 77, figs. 5, 6.

HELICOSTYLA TICAONICA Broderip. TICAO; MASBATE; CEBU; NEGROS.

Helix ticaonica BRODERIP, Proc. Zool. Soc. London (1840) 155; Man. Conchol. II **7** (1891) 203, pl. 62, figs. 25–28; **9** (1894) 227; Abh. Naturf. Ges. **22** (1898) 115; Obras Malacológicas (1890) 380, pl. 41, fig. 5; pl. 66, figs. 1–4; pl. 70, fig. 1; pl. 131, fig. 7.

HELICOSTYLA TRISCULPTA Moellendorff. SIBUYAN (?).

Obras Malacológicas (1890) 287; Nachrichbl. Malak. Ges. **26** (1894) 97.

HELICOSTYLA TURBINOIDES Broderip. LUZON.

Helix turbinoides BRODERIP, Proc. Zool. Soc. London (1840) 123; Conchol. Icon. **7** (1854) *Helix* pl. 2, figs. 6*a*, 6*b*; Man. Conchol. II **7** (1891) 196, pl. 47, fig. 63; pl. 62, fig. 29; **9** (1894) 227; Obras Malacológicas (1890) 365, pl. 28, figs. 1, 2; pl. 29, fig. 1; Abh. Naturf. Ges. **22** (1898) 111.

HELICOSTYLA TURRIS Semper. ISABELA.

Man. Conchol. II **8** (1892) 23, pl. 13, fig. 56; Reisen Philippinen **3** (1870) 210, pl. 9, fig. 3.

HELICOSTYLA UBER Pfeiffer. GUIMARAS.

Man. Conchol. II **8** (1892) 41, pl. 7, fig. 44; **9** (1894) 230; Obras Malacológicas (1890) 422, pl. 119, fig. 4.

HELICOSTYLA UNICA Pfeiffer. ZAMBOANGA.

Helix unica PFEIFFER, Proc. Zool. Soc. London (1842) 151; Conchol. Icon. 7 (1854) *Helix* pl. 18, fig. 74; Man. Conchol. II 7 (1891) 189, pl. 36, fig. 33; 9 (1894) 225; Obras Malacológicas (1890) 449, pl. 112, fig. 2.

HELICOSTYLA VELATA Broderip. CEBU; CAMOTES ISLANDS; LEYTE.

Man. Conchol. II 8 (1892) 12, pl. 12, fig. 12; 9 (1894) 231; Obras Malacológicas (1890) 525, pl. 85, figs. 3–6; pl. 79, fig. 7; pl. 131, fig. 6.

HELICOSTYLA VENTRICOSA Chemnitz. GUIMARAS.

Man. Conchol. II 8 (1892) 10, pl. 3, figs. 23–29, 31; 9 (1894) 228; *Cochlostyla decorata* FERUSSAC, Abh. Naturf. Ges. 22 (1898) 101; Obras Malacológicas (1890) 411, pl. 79, fig. 8; pl. 80, figs. 7, 8; pl. 85, fig. 1; pl. 115, fig. 4; *Cochlostyla frater* FERUSSAC, 100; *Cochlostyla nobilis* REEVE, Obras Malacológicas (1890) 409, pl. 79, figs. 1, 2.

HELICOSTYLA VERSICOLOR Moellendorff. NUEVA ECIJA.

Man. Conchol. II 8 (1892) 246; 9 (1894) 225; Obras Malacológicas (1890) 495, pl. 84, fig. 7; Nachrichbl. Malak. Ges. 26 (1894) 98.

HELICOSTYLA VIDALI Hidalgo. MOUNTAIN PROVINCE.

Man. Conchol. II 7 (1891) 208, pl. 60, fig. 12; 9 (1894) 229; Obras Malacológicas (1890) 31, 371, pl. 60, fig. 5.

HELICOSTYLA VILLARI Hidalgo. MARINDUQUE.

Man. Conchol. II 7 (1891) 201, pl. 40, fig. 1; 9 (1894) 227; Obras Malacológicas (1890) 32.

HELICOSTYLA VIRGATA Jay. MINDORO.

Man. Conchol. II 8 (1892) 48, pl. 16, figs. 11–15; pl. 17, fig. 35; 9 (1894) 231, *Cochlostyla sylvanoides* SEMPER, Reisen Philippinen 3 (1870) 222, pl. 10, fig. 4; Obras Malacológicas (1890) 509, pl. 44, figs. 1–7; *Cochlostyla porracea* JAY, 504, pl. 82, figs. 1–8; pl. 98, figs. 4–7; pl. 127, fig. 6.

HELICOSTYLA VIRGINEA Lea. LUZON; MINDORO; CATANDUANES.

Man. Conchol. II 8 (1892) 36, pl. 7, figs. 31–37, 39, 40; 9 (1894) 229; Obras Malacológicas (1890) 486, pl. 59, figs. 2–4; *Cochlostyla bustoi* HIDALGO, 29, 485, pl. 59, figs. 5, 6.

HELICOSTYLA VIRGO Broderip. CEBU; ZAMBOANGA.

Helix virgo BRODERIP, Proc. Zool. Soc. London (1841) 44; Conchol. Icon. 7 (1854) *Helix* pl. 21, fig. 89; Obras Malacológicas (1890) 147, 204, pl. 22, fig. 1; Man. Conchol. II 7 (1891) 119, pl. 24, figs. 29, 30; 9 (1894) 219.

HELICOSTYLA VIRIDOSTRIATA Lea. TEMPLE, NEAR BURIAS.

Man. Conchol. II 7 (1891) 178, pl. 38, figs. 74–78; 9 (1894) 225; Obras Malacológicas (1890) 457, pl. 90, figs. 2, 3; pl. 109, figs. 1–4; pl. 122, fig. 5; *Cochlostyla polychroa* SOWERBY, Reisen Philippinen 3 (1870) 199; *Helix polychroa* SOWERBY, Proc. Zool. Soc. London (1840) 87; Conchol. Icon. 7 (1854) *Helix* pl. 11, figs. 44*a*–44*d*.

HELICOSTYLA WEBERI Bartsch. CANDARAMAN ISLAND.

Proc. Biol. Soc. Wash. 32 (1919) 181.

HELICOSTYLA WOODIANA Lea. LAGUNA; TAYABAS; CAMARINES NORTE.

Helix reevii BRODERIP, Proc. Zool. Soc. London (1840) 34; Man. Conchol. II 7 (1891) 206, pl. 43, figs. 28, 29; 9 (1893) 227; Obras Malacológicas (1890) 369, pl. 55, fig. 1; pl. 56, fig. 3; Proc. Biol. Soc. Wash. **31** (1918) 153.

HELICOSTYLA WORCESTERI Bartsch. BANTAYAN ISLAND, CEBU.

Proc. U. S. Nat. Mus. **37** (1909) 295, pl. 29, figs. 14, 16.

HELICOSTYLA XANTHOBASIS Pilsbry. ALBAY.

Man. Conchol. II 7 (1891) 155, pl. 54, figs. 38–40; 9 (1894) 223.

HELICOSTYLA ZEBUENSIS Broderip. CEBU.

Helix zebuensis BRODERIP, Proc. Zool. Soc. London (1841) 46; Conchol. Icon. 7 (1854) *Helix* pl. 31, figs. 133*a*, 133*b*; Man. Conchol. II 7 (1891) 161, pl. 20, figs. 3–6; 9 (1894) 223; Obras Malacológicas (1890) 143, 200, pl. 11, figs. 4, 5; pl. 145; figs. 1, 2.

HELICOSTYLA ZONIFERA Sowerby. SAMAR; LEYTE; MINDANAO.

Helix zonifera SOWERBY, Proc. Zool. Soc. London (1842) 85; Conchol. Icon. 7 (1854) *Helix* pl. 9, figs. 4*a*–4*d*; Man. Conchol. II 7 (1891) 141, pl. 35, figs. 19, 20, 22; 9 (1894) 222; Reisen Philippinen 3 (1870) 177, pl. 18, fig. 9; Obras Malacológicas (1890) 321, pl. 46, figs. 3–5; *Cochlostyla paraleuca* PILSBRY, 319, pl. 36, figs. 1, 2; pl. 96, figs. 3, 4; pl. 129, figs. 3–5; *Helix circe* PFEIFFER, Proc. Zool. Soc. London (1853) 49; Conchol. Icon. 7 (1854) *Helix* pl. 156, fig. 1025; Obras Malacológicas (1890) 322, pl. 38, fig. 3; pl. 46, fig. 5; pl. 141, fig. 3.

Genus AMPHIDROMUS Albers

AMPHIDROMUS APOENSIS Bartsch. MOUNT APO, MINDANAO.

Bull. U. S. Nat. Mus. **100** (1917) 19, pl. 9, figs. 5, 6.

AMPHIDROMUS BASILANENSIS Bartsch. BASILAN ISLAND.

Bull. U. S. Nat. Mus. **100** (1917) 20, pl. 9, figs. 3.

AMPHIDROMUS BILATANENSIS Bartsch. BILATAN ISLAND.

Bull. U. S. Nat. Mus. **100** (1917) 23, pl. 10, figs. 4, 5.

AMPHIDROMUS CALLISTA Pilsbry. PHILIPPINES.

Bull. U. S. Nat. Mus. **100** (1917) 23, pl. 11, figs. 1–3. See *Amphidromus chloris* Reeve.

AMPHIDROMUS CHLORIS Reeve. ZAMBOANGA.

Man. Conchol. II **13** (1900) 142, pl. 50, figs. 28–38; Bull. U. S. Nat. Mus. **100** (1917) 24–26; Reisen Philippinen 3 (1870) 148.

AMPHIDROMUS DUBIUS Fulton. BALABAC.

Ann. & Mag. Nat. Hist. XVII 6 (1896) 86, pl. 6, figs. 1, 1*a*; Abh. Naturf. Ges. 22 (1898) 125. See *Amphidromus quadrasi* Hidalgo.

AMPHIDROMUS ENTOBAPTUS Dohrn. PALAWAN.

Man. Conchol. II **13** (1900) 145, pl. 51, figs. 42–46; Bull. U. S. Nat. Mus. **100** (1917) 28–32, many figures.

AMPHIDROMUS EVERETTI Fulton. PALAWAN.

Ann. & Mag. Nat. Hist. XVII **6** (1896) 87; Abh. Naturf. Ges. **22** (1898) 125. See *Amphidromus quadrasi* Hidalgo.

AMPHIDROMUS FLORESI Bartsch. MINDANAO.

Bull. U. S. Nat. Mus. **100** (1917) 20, pl. 8, fig. 3.

AMPHIDROMUS HIDALGOI Bartsch. DAPITAN, MINDANAO.

Bull. U. S. Nat. Mus. **100** (1917) 23, pl. 11, figs. 4, 6.

AMPHIDROMUS INFLATUS Fulton. PHILIPPINES.

Bull. U. S. Nat. Mus. **100** (1917) 21, pl. 1, fig. 3; pl. 10, figs. 6, 7.

AMPHIDROMUS LINDSTEDTI Pfeiffer. BALABAC.

Man. Conchol. II **13** (1900) 228, pl. 70, figs. 70, 71; Ann. & Mag. Nat. Hist. XVII **6** (1896) 85, pl. 5, figs. 15, 15*a*.

AMPHIDROMUS MACULIFERUS Sowerby. SULU ARCHIPELAGO; MINDANAO.

Man. Conchol. II **13** (1900) 130, pl. 49, figs. 19–21; Ann. & Mag. Nat. Hist. XIII **6** (1894) 55, pl. 4, figs. 9, 9*a*; XVII (1896) 74–76; Abh. Naturf. Ges. **22** (1898) 124; Bull. U. S. Nat. Mus. **100** (1917) 10–18, pl. 1, figs. 1, 2; pl. 2, figs. 1–5; pl. 3, figs. 1–5; pl. 4, figs. 1–8; pl. 5, figs. 1–6; pl. 6, figs. 1–5; pl. 7, figs. 1–6; pl. 8, figs. 1, 2, 4, 5; Proc. Biol. Soc. Wash. **32** (1919) 183; Reisen Philippinen **3** (1870) 148.

AMPHIDROMUS MALINDANGENSIS Bartsch. MOUNT MALINDANG, MINDANAO.

Bull. U. S. Nat. Mus. **100** (1917) 19, pl. 9, figs. 1, 2.

AMPHIDROMUS MEARNSI Bartsch. BASILAN.

Bull. U. S. Nat. Mus. **100** (1917) 22, pl. 10, figs. 1, 2.

AMPHIDROMUS MINDOROENSIS Bartsch. MINDORO.

Bull. U. S. Nat. Mus. **100** (1917) 33, pl. 15, figs. 4, 5.

AMPHIDROMUS PALLIDULUS Pilsbry. ZAMBOANGA.

Bull. U. S. Nat. Mus. **100** (1917) 22, pl. 10, figs. 3, 8. See *Amphidromus chloris* Reeve.

AMPHIDROMUS QUADRASI Hidalgo. BALABAC.

Ann. & Mag. Nat. Hist. XI **6** (1893) 350, pl. 18, figs. 10–13; XVII (1896) 85, 86, pl. 5, fig. 16; Obras Malacológicas (1890) 17; Man. Conchol. II **13** (1900) 229, pl. 71, figs. 72–78; Bull. U. S. Nat. Mus. **100** (1917) 34–40, many figures; Journ. Wash. Acad. Sci. **8** (1918) 361–367.

AMPHIDROMUS ROESELERI Moellendorff. SULU.

Man. Conchol. II **13** (1900) 144; Ann. & Mag. Nat. Hist. XVII **6** (1896) 75; Bull. U. S. Nat. Mus. **100** (1917) 27, pl. 13, figs. 1–3.

AMPHIDROMUS SULUENSIS Bartsch. ISLANDS OF THE SULU SEA.

Bull. U. S. Nat. Mus. **100** (1917) 26, pl. 1, fig. 5; pl. 11, figs. 5, 7–9; pl. 12, figs. 7, 9.

AMPHIDROMUS VERSICOLOR Fulton. BALABAC.

Ann. & Mag. Nat. Hist. XVII **6** (1896) 86; Abh. Naturf. Ges. **22** (1898) 125; Proc. Biol. Soc. Wash. 32 (1919) 182; Journ. Wash. Acad. Sci. **8** (1918) 363–367. See *Amphidromus quadrasi* Hidalgo.

Family ACHATINIDÆ

Genus PROSOPEAS Mörch

PROSOPEAS COCHLIODES Pfeiffer. CUYO; SIBUYAN; TABLAS.

Man. Conchol. II 18 (1906–7) 16, pl. 5, figs. 25–27.

PROSOPEAS ELONGATULUM Pfeiffer. LUZON.

Man. Conchol. II 18 (1906–7) 17, pl. 5, figs. 28, 29.

PROSOPEAS MACILENTUM Reeve. LUZON; CEBU.

Man. Conchol. II 18 (1906–7) 19, pl. 5, fig. 32.

PROSOPEAS PAGODA Semper. MONTALBAN, RIZAL.

Man. Conchol. II 18 (1906–7) 18; *Stenogyra pagoda* SEMPER, Reisen Philippinen 3 (1870) 138.

PROSOPEAS QUADRASI Hidalgo. GIGAQUIT, SURIGAO.

Man. Conchol. II 18 (1906–7) 18, pl. 5, figs. 30, 31; *Stenogyra quadrasi* HIDALGO, Obras Malacológicas (1890) 35.

PROSOPEAS RHODINÆFORME Moellendorff. SIBUYAN; TABLAS.

Man. Conchol. II 18 (1906–7) 17; Nachrichbl. Malak. Ges. 26 (1894) 106.

PROSOPEAS ROMBLONICUM Moellendorff. ROMBLON.

Man. Conchol. II 18 (1906–7) 18; Nachrichbl. Malak. Ges. 28 (1896) 12.

PROSOPEAS SUTURALE Moellendorff. CEBU.

Man. Conchol. II 18 (1906–7) 15, pl. 5, figs. 23, 24; Senckenberg. Naturf. Ges. (1890) 246, pl. 8, fig. 10.

Genus CURVELLA Chaper

(*Hapalus* Albers)

CURVELLA ALABASTRINA Da Costa. GUIMARAS.

Man. Conchol. II 18 (1906–7) 340, pl. 50, figs. 27, 28.

CURVELLA BREVIS Quadras and Moellendorff. BOHOL.

Man. Conchol. II 18 (1906–7) 69; *Hapalus brevis* QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 28 (1896) 87.

CURVELLA DECURTATA Quadras and Moellendorff. BATAAN.

Man. Conchol. II 18 (1906–7) 68.

CURVELLA GRATELOUPI Pfeiffer. ALBAY; SAMAR; LEYTE; CEBU; PANAY.

Man. Conchol. II 18 (1906–7) 68, pl. 6, figs. 68, 69.

CURVELLA MINUTA Da Costa. BUSUANGA.

Man. Conchol. II 18 (1906–7) 340, pl. 50, figs. 29–31.

CURVELLA PERFORATA Moellendorff. MONTALBAN, RIZAL.

Man. Conchol. II 18 (1906–7) 70, pl. 9, figs. 61–63; Senckenberg. Naturf. Ges. (1890) 246, pl. 8, fig. 7.

CURVELLA PHILIPPINICA Pilsbry. CAGAYAN.

Man. Conchol. II 18 (1906–7) 70, pl. 6, figs. 66, 67.

CURVELLA QUADRASI Moellendorff. CAGAYAN.

Man. Conchol. II 18 (1906–7) 69.

CURVELLA SCALARIS Quadras and Moellendorff. CATANDUANES; CAMARINES NORTE.

Man. Conchol. II 18 (1906–7) 69.

CURVELLA UMBILICATA Moellendorff. CEBU.

Man. Conchol. II 18 (1906–7) 71, pl. 9, figs. 64, 65; Senckenberg. Naturf. Ges. (1890) 245, pl. 8, fig. 8.

Genus SUBULINA Beck

SUBULINA OCTONA Bruguière. MANILA.

Man. Conchol. II 18 (1906–7) 72, pl. 12, figs. 8, 9.

Genus OPEAS Albers

OPEAS ARAYATENSE Semper. PAMPANGA.

Man. Conchol. II 18 (1906–7) 180; *Stenogyra arayatensis* SEMPER, Reisen Philippinen 3 (1870) 139.

OPEAS CLAVULINUM Potiez and Michaud. LEYTE (?). MAURITIUS SPECIES.

Senckenberg. Naturf. Ges. (1893) 100.

OPEAS GRACILE Hutton. LUZON; CEBU; MINDANAO.

Man. Conchol. II 18 (1906–7) 125, pl. 18, figs. 3–6; *Stenogyra panayensis* PFEIFFER, Reisen Philippinen 3 (1870) 137, pl. 8, fig. 15; pl. 11, figs. 17, 21.

OPEAS HEXAGYRUM Boettger. CEBU; LEYTE.

Man. Conchol. II 18 (1906–7) 180, pl. 19, fig. 26; Senckenberg. Naturf. Ges. (1890) 248, pl. 8, fig. 11.

OPEAS JAVANICUM Reeve. CEBU; MINDANAO.

Man. Conchol. II 18 (1906–7) 138, pl. 12, figs. 14, 16; pl. 16, figs. 81, 88; pl. 22, fig. 9.

OPEAS MINUTUM Semper. PAMPANGA.

Man. Conchol. II 18 (1906–7) 180; *Stenogyra minuta* SEMPER, Reisen Philippinen 3 (1870) 139.

OPEAS MONTANUM Semper. PAMPANGA; RIZAL.

Man. Conchol. II 18 (1906–7) 179; *Stenogyra montana* SEMPER, Reisen Philippinen 3 (1870) 139.

OPEAS NITIDUM Quadras and Moellendorff. CAGAYAN.

Man. Conchol. II 18 (1906–7) 181.

OPEAS PILOSUM Semper. BATAAN.

Man. Conchol. II 18 (1906–7) 179; *Stenogyra pilosa* SEMPER, Reisen Philippinen 3 (1870) 138.

OPEAS SEMPERI Hidalgo. SURIGAO.

Stenogyra semperi HIDALGO, Obras Malacológicas (1890) 36; Man. Conchol. II 18 (1906–7) 178, pl. 19, fig. 28.

OPEAS SUBCRENULATUM Moellendorff. CAMARINES NORTE.

Man. Conchol. II 18 (1906–7) 181.

Family FERUSSACIDÆ Bourguignat

Genus CAECILIOIDES Herrmannsen

(*Geostilbia* Crosse)

CAECILIOIDES MOELLENDORFFI Pilsbry. CEBU.

Man. Conchol. II 20 (1909–10) 50, pl. 15, figs. 4, 5.

CAECILIOIDES PHILIPPINENSIS Semper. ZAMBOANGA.

Man. Conchol. II 20 (1909–10) 49; *Cionella philippinensis* SEMPER, Reisen Philippinen 3 (1870) 139.

CAECILIOIDES PHILIPPINICA Moellendorff. CEBU.

Man. Conchol. II 20 (1909–10) 49, pl. 15, figs. 6, 7; *Geostilbia philippinica* MOELLENDORFF, Senckenberg. Naturf. Ges. (1890) 248, pl. 8, fig. 8.

Family TORNATELLINIDÆ Pilsbry

Genus ELASMIAS Pilsbry

ELASMIAS MANILENSE Dohrn. MANILA; BOHOL.

Man. Conchol. II 23 (1915–16) 125; *Tornatellina manilensis* DOHRN, Reisen Philippinen 3 (1870) 133, 140.

Genus TORNATELLINA Pfeiffer

TORNATELLINA CAMARINICA Moellendorff. CAMARINES NORTE.

Man. Conchol. II 23 (1915–16) 186.

TORNATELLINA GLOBULOSA Quadras and Moellendorff. LUZON; MINDANAO.

Abh. Naturf. Ges. 22 (1898) 128.

TORNATELLINA KOCHIANA Moellendorff. CEBU.

Man. Conchol. II 23 (1915–16) 185, pl. 38, figs. 14, 15; pl. 40, figs. 11, 12.

TORNATELLINA RINGENS Dohrn. PHILIPPINES.

Man. Conchol. II 23 (1915–16) 141.

Family PUPILLIDÆ Turton

Genus GASTROCOPTA Wollaston

(*Leucochilus* Boettger)

GASTROCOPTA CAPILLACEA Dohrn and Semper. MINDANAO.

Man. Conchol. II 24 (1916–18) 144; *Pupa capillacea* DOHRN and SEMPER, Reisen Philippinen 3 (1870) 140.

GASTROCOPTA EURYOMPHALA Moellendorff. BUSUANGA.

Abh. Naturf. Ges. 22 (1898) 127.

GASTROCOPTA LYONSIANA Ancey. BULACAN; LAGUNA; LEYTE.

Man. Conchol. II 24 (1916–18) 141, pl. 24, figs. 1–4; *Leucochilus artense* MONTROUZIER, Abh. Naturf. Ges. 22 (1898) 127.

GASTROCOPTA MOELLENDORFFIANA Pilsbry. BOHOL.

Man. Conchol. II 24 (1916–18) 145, pl. 24, figs. 8, 12, 13.

GASTROCOPTA PEDICULUS Shuttleworth. LEYTE.

Man. Conchol. II 24 (1916–18) 145, pl. 25, figs. 1–3, 5–8, 12–15.

Genus HYPSELOSTOMA Benson

HYPSELOSTOMA EDENTULUM Moellendorff. SANGAT ISLAND, CALAMIANES GROUP.

Man. Conchol. II 24 (1916–18) 187, pl. 32, fig. 12; Nachrichbl. Malak. Ges. **26** (1894) 100.

HYPSELOSTOMA LUZONICUM Moellendorff. RIZAL.

Man. Conchol. II 24 (1916–18) 183, pl. 32, figs. 7, 8, 9; Senckenberg. Naturf. Ges. (1890) 250, pl. 9, fig. 1.

HYPSELOSTOMA POLYODON Moellendorff. TABLAS.

Man. Conchol. II 24 (1916–18) 185; Nachrichbl. Malak. Ges. **28** (1896) 12.

HYPSELOSTOMA PUSILLUM Moellendorff. CORON.

Man. Conchol. II 24 (1916–18) 186; Nachrichbl. Malak. Ges. **26** (1894) 100.

HYPSELOSTOMA QUADRASI Moellendorff. BOHOL.

Man. Conchol. II 24 (1916–18) 185, pl. 32, fig. 5; Nachrichbl. Malak. Ges. **28** (1896) 88.

HYPSELOSTOMA ROEBELENI Moellendorff. CORON; BUSUANGA.

Man. Conchol. II 24 (1916–18) 186, pl. 31, figs. 8–10; Nachrichbl. Malak. Ges. **26** (1894) 100.

HYPSELOSTOMA SIBUYANICUM Moellendorff. SIBUYAN.

Man. Conchol. II 24 (1916–18) 184; Nachrichbl. Malak. Ges. **28** (1896) 11.

Genus AULACOSPIRA Moellendorff

AULACOSPIRA AZPEITIAE Hidalgo. BUSUANGA.

Helix azpeitiae HIDALGO, Obras Malacólogicas (1890) 120, 169, pl. 1, fig. 10; Man. Conchol. II **9** (1894) 199, pl. 54, fig. 93; **24** (1916–18) 224, pl. 38, figs. 14, 17.

AULACOSPIRA HOLOLOMA Moellendorff. MOUNT LICOS, CEBU.

Helix hololoma MOELLENDORFF, Obras Malacológicas (1890) 119, 169, pl. 157, figs. 3, 4; Man. Conchol. II **8** (1892) 198, pl. 54, figs. 89, 90; **9** (1894) 280; 24 (1916–18) 222, pl. 38, figs. 6, 7.

AULACOSPIRA MUCRONATA Moellendorff. CEBU.

Helix mucronata MOELLENDORFF, Obras Malacológicas (1890) 119, 168, pl. 157, figs. 5, 6; Man. Conchol. II **8** (1892) 198, pl. 54, figs. 91, 92; **9** (1894) 280; **24** (1916–18) 222, pl. 38, fig. 1.

AULACOSPIRA PORRECTA Quadras and Moellendorff. ILIN ISLAND, NEAR MINDORO.

Helix porrecta QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 169, pl. 157, figs. 7, 8; Man. Conchol. II **9** (1894) 280; **24** (1916–18) 222, pl. 38, fig. 2; Nachrichbl. Malak. Ges. **26** (1894) 95.

AULACOSPIRA RHOMBOSTOMA **Moellendorff.** TABLAS.

Helix rhombostoma MOELLENDORFF, Obras Malacológicas (1890) 169; Man. Conchol. II 24 (1916–18) 223, pl. 38, fig. 13; Nachrichbl. Malak. Ges. **28** (1896) 8.

AULACOSPIRA SCALATELLA **Moellendorff.** ANTIPOLO, RIZAL.

Helix scalatella MOELLENDORFF, Obras Malacológicas (1890) 119, 169, pl. 157, figs. 9–11; Man. Conchol. II **8** (1892) 199; 9 (1894) 280; 24 (1916–18) 223, pl. 38, figs. 8, 9.

AULACOSPIRA TRIPTYCHA **Quadras and Moellendorff.** MASBATE.

Helix triptycha QUADRAS and MOELLENDORFF, Obras Malacológicas (1890) 169; Man. Conchol. II 24 (1916–18) 223; Nachrichbl. Malak. Ges. 27 (1895) 76.

Genus NESOPUPA Pilsbry

NESOPUPA MALAYANA **Issel.** PHILIPPINES.

Man. Conchol. II 25 (1918–20) 342, pl. 32, figs. 14–16.

NESOPUPA MOELLENDORFFI **Boettger.** LUZON; CEBU; SIQUIJOR; MINDANAO

Man. Conchol. II 25 (1918–20) 341, pl. 32, figs. 4, 5; *Ptychochilus moellendorffi* BOETTGER, Senckenberg. Naturf. Ges. (1890) 252, pl. 9, fig. 4.

NESOPUPA MORELETI **Brown.** PHILIPPINES.

Man. Conchol. II 25 (1918–20) 339, pl. 32, figs. 1, 2, 3, 6.

NESOPUPA NANNODES **Quadras and Moellendorff.** BOHOL.

Man. Conchol. II 25 (1918–20) 341, pl. 32, fig. 13.

Genus COSTIGO Boettger

COSTIGO CALAMIANICA **Moellendorff.** BUSUANGA.

Man. Conchol. II 25 (1918–20) 367.

Genus PUPISOMA Stoliczka

PUPISOMA ORCULA **Benson.** PHILIPPINES.

Man. Conchol. II 26 (1920–21) 31, pl. 2, figs. 1–5.

PUPISOMA PHILIPPINICUM **Moellendorff.** RIZAL; CEBU; MINDANAO.

Helix philippinica MOELLENDORFF, Obras Malacológicas (1890) 119, 168, pl. 157, figs. 1, 2; Man. Conchol. II 26 (1920–21) 33, pl. 2, fig. 3; **9** (1894) 52; Senckenberg. Naturf. Ges. (1890) 223, pl. 8, figs. 4–4*b*; (1893) 80.

Family BULIMINIDÆ Moellendorff

Genus RHACHIS Albers

RHACHIS ZONULATA **Pfeiffer.** CULION; BUSUANGA.

Abh. Naturf. Ges. 22 (1898) 125.

Family SUCCINEIDÆ Moellendorff

Genus SUCCINEA Moellendorff

SUCCINEA MONTICULA Semper. LUZON.

Abh. Naturf. Ges. 22 (1898) 131.

SUCCINEA PHILIPPINICA Moellendorff. LUZON; CEBU; MINDANAO.

Abh. Naturf. Ges. 22 (1898) 131; Senckenberg. Naturf. Ges. (1893) 101, pl. 3, figs. 10–10*b*.

Family CLAUSILIIDÆ Moellendorff

Genus CLAUSILIA Draparnaud

CLAUSILIA CUMINGIANA Pfeiffer. SIQUIJOR.

Conchol. Icon. 20 (1878) *Clausilia* pl. 10, fig. 88; Nachrichbl. Malak. Ges. 23 (1891) 47; Abh. Naturf. Ges. 22 (1898) 127.

Family TRUNCATELLIDÆ

Genus TRUNCATELLA Risso

(*Taheitia* A. Adams)

TRUNCATELLA ALBIDA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 137, pl. 5, figs. 11–11*b*.

TRUNCATELLA ANCTOSTOMA Quadras and Moellendorff. GUIMARAS; MINDANAO; PALAWAN.

Taheitia anctostoma QUADRAS and MOELLENDORFF, Nachrichbl. Malak. Ges. 29 (1897) 31.

TRUNCATELLA CONSPICUA Bronn. BOHOL.

Cat. Auriculidae, etc. (1857) 134.

TRUNCATELLA MARGINATA Kuster. CEBU.

Abh. Naturf. Ges. 22 (1898) 142.

TRUNCATELLA QUADRASI Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 137, pl. 5, figs. 10–10*b*.

TRUNCATELLA SEMPERI Kobelt. BOHOL; CEBU.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 2, pl. 1, fig. 11; Senckenberg. Naturf. Ges. (1890) 292.

TRUNCATELLA VALIDA Pfeiffer. BOHOL; MINDANAO.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 1, pl. 1, fig. 10; Cat. Auriculidae, etc. (1857) 133.

TRUNCATELLA VITIANA Gould. BOHOL.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 3, pl. 1, fig. 12. See *Truncatella conspicua* Bronn.

Family CYCLOPHORIDÆ

Genus LEPTOPOMA Pfeiffer

LEPTOPOMA ACHATINUM Crosse. PHILIPPINES.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 56.

LEPTOPOMA ACUMINATUM Sowerby. LUZON.

Conchol. Icon. 13 (1862) *Leptopoma* pl. 1, fig. 2; Reisen Philippinen Kobelt Landdeckelschnecken 4 (1886) 36, pl. 5, fig. 15; Cat. Phaneropneumona Brit. Mus. (1852) 82.

LEPTOPOMA ACUTIMARGINATUM Sowerby. SAMAR.

Cat. Phaneropneumona Brit. Mus. (1852) 77; Conchol. Icon. 12 (1862) *Leptopoma* pl. 1, figs. 4*a*, 4*b*. See *Cyclophorus acutimarginatus* Sowerby.

LEPTOPOMA AMALIAE Kobelt. PHILIPPINES (?).

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 45, pl. 6, figs. 24–26.

LEPTOPOMA ANTONII Kobelt. CAGAYAN.

Abh. Naturf. Ges. 22 (1898) 146.

LEPTOPOMA APPROXIMANS Dohrn. PHILIPPINES.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 46, pl. 6, fig. 27.

LEPTOPOMA ATRICAPILLUM Sowerby. MINDORO; ZAMBOANGA; SULU ARCHIPELAGO.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 50, pl. 7, figs. 6–8; Cat. Phaneropneumona Brit. Mus. (1852) 81; Conchol. Icon. 13 (1862) *Leptopoma* pl. 1, figs. 6*a*, 6*b*; Ann. & Mag. Nat. Hist. XIII 6 (1894) 57.

LEPTOPOMA AUREUM Quadras and Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 28 (1896) 89.

LEPTOPOMA BICOLOR Pfeiffer. BOHOL.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 56.

LEPTOPOMA BIPARTITUM Kobelt. MINDANAO.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 43, pl. 6, figs. 19–23.

LEPTOPOMA BOETTGERI Moellendorff. CEBU; BOHOL.

Abh. Naturf. Ges. 22 (1898) 144.

LEPTOPOMA BOHOLENSE Kobelt. LUZON; BOHOL; SAMAR.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 48, pl. 6, figs. 17, 18.

LEPTOPOMA CAROLI Dohrn. NORTHERN LUZON.

Proc. Zool. Soc. London (1862) 182; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 37, pl. 5, figs. 16–18.

LEPTOPOMA CILIATUM Sowerby. CAMARINES SUR.

Conchol. Icon. 12 (1862) *Leptopoma* pl. 7, fig. 39; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 57; Cat. Phaneropneumona Brit. Mus. (1852) 78. See *Lagochilus ciliatum* Sowerby.

LEPTOPOMA CONCINNUM Sowerby. LEYTE; MINDANAO.

Senckenberg. Naturf. Ges. (1893) 119.

LEPTOPOMA CUTICULARE Moellendorff. LUZON.

Nachrichbl. Malak. Ges. **20** (1888) 75.

LEPTOPOMA DISTINGUENDUM Dohrn. PALAWAN.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 55, pl. 7, figs. 13, 14.

LEPTOPOMA DUBIUM Kobelt. PHILIPPINES.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 42, pl. 6, figs. 13, 14.

LEPTOPOMA EUCONUS Moellendorff. CORON.

Nachrichbl. Malak. Ges. **26** (1894) 111.

LEPTOPOMA FIBULA Sowerby. LUZON.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 34, pl. 5, figs. 6–9; Cat. Phaneropneumona Brit. Mus. (1852) 79; Conchol. Icon. **13** (1862) *Leptopoma* pl. 1, figs. 5*a*, 5*b*.

LEPTOPOMA FIBULINUM Quadras and Moellendorff. CALAMIANES.

Nachrichbl. Malak. Ges. **29** (1897) 33.

LEPTOPOMA FREERI Bartsch. CALAYAN ISLAND, BABUYANES.

Proc. U. S. Nat. Mus. **37** (1909) 297, pl. 29, figs. 6, 7, 9.

LEPTOPOMA GONIOSTOMA Sowerby. MISAMIS.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 39, pl. 5, figs. 28–32; Proc. Biol. Soc. Wash. **32** (1919) 18; Cat. Phaneropneumona Brit. Mus. (1852) 80; Conchol. Icon. **13** (1862) *Leptopoma* pl. 1, fig. 1.

LEPTOPOMA HELICOIDES Grateloup. MASBATE; SIQUIJOR; SAMAR.

Cat. Phaneropneumona Brit. Mus. (1852) 78; Conchol. Icon. **13** (1862) *Leptopoma* pl. 2, figs. 11*a*–11*d*; Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 35, pl. 5, figs. 10–14; 48, pl. 7, figs. 1, 2.

LEPTOPOMA IMMACULATUM Chemnitz. LUZON.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 49, pl. 7, figs. 3–5; Cat. Phaneropneumona Brit. Mus. (1852) 74.

LEPTOPOMA INSIGNE Sowerby. MINDORO.

Cat. Phaneropneumona Brit. Mus. (1852) 78; Conchol. Icon. **13** (1862) *Leptopoma*, pl. 6, figs. 34*a*, 34*b*; Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 58.

LEPTOPOMA INTUSZONATUM Hidalgo. PALAWAN.

Abh. Naturf. Ges. **22** (1898) 143.

LEPTOPOMA LÆVE Wood. PHILIPPINES.

Conchol. Icon. **13** (1862) *Leptopoma* pl. 3, figs. 17*a*–17*c*.

LEPTOPOMA LATELIMBATUM Pfeiffer. LUZON; POLILLO.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 44; Cat. Phaneropneumona Brit. Mus. (1852) 75; Conchol. Icon. **13** (1862) *Leptopoma* pl. 2, figs. 12*a*, 12*b*.

LEPTOPOMA LUTEOSTOMUM Sowerby. GUIMARAS.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 57; Cat. Phaneropneumona Brit. Mus. (1852) 74; Conchol. Icon. **13** (1862) *Leptopoma*, pl. 6, fig. 37.

LEPTOPOMA MACULATUM Lea. LUZON; BURIAS.

Abh. Naturf. Ges. **22** (1898) 144.

LEPTOPOMA MANHANENSE Kobelt. LUZON.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 32, pl. 5, figs. 1, 2; *Leptopoma maubanense makabengana* BARTSCH, Proc. U. S. Nat. Mus. **55** (1919) 306, pl. 20, figs. 4–6.

LEPTOPOMA MATHILDAE Dohrn. ZAMBOANGA.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 47, pl. 6, figs. 31, 32; Proc. Zool. Soc. London (1862) 182.

LEPTOPOMA NITIDUM Sowerby. LUZON; VISAYAN ISLANDS.

Proc. Biol. Soc. Wash. **32** (1919) 19; Journ. Wash. Acad. Sci. **8** (1918) 532–535.

LEPTOPOMA PALAWANENSIS Smith. PALAWAN.

Ann. & Mag. Nat. Hist. XI **6** (1893) 352, pl. 18, figs. 20, 21.

LEPTOPOMA PANAYENSE Sowerby. PANAY; SAMAR.

Cat. Phaneropneumona Brit. Mus. (1852) 76; Conchol. Icon. **13** (1862) *Leptopoma* pl. 6, fig. 31; Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 58.

LEPTOPOMA PERLUCIDUM Grateloup. BOHOL; MINDANAO.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 40, pl. 6, figs. 1–12; Cat. Phaneropneumona Brit. Mus. (1852) 72; *Leptopoma pellucidum* GRATELOUP, Conchol. Icon. **13** (1862) *Leptopoma* pl. 5, figs. 27*a*, 27*b*; Senckenberg. Naturf. Ges. (1890) 276.

LEPTOPOMA PERPLEXUM Sowerby. LUZON.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 39, pl. 5, figs. 24–27; Cat. Phaneropneumona Brit. Mus. (1852) 77; Conchol. Icon. **13** (1862) *Leptopoma* pl. 3, figs. 16*a*, 16*b*.

LEPTOPOMA PFEIFFERI Dohrn. CAMIGUIN; MINDANAO (?).

Proc. Zool. Soc. London (1862) 182; Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 43, pl. 6, figs. 15, 16.

LEPTOPOMA PILEOLUS Quadras and Moellendorff. CAGAYAN.

Nachrichbl. Malak. Ges. **27** (1895) 143.

LEPTOPOMA PILEUS Sowerby. NORTHERN LUZON.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 37, pl. 5, figs. 19–23; Cat. Phaneropneumona Brit. Mus. (1852) 80; Conchol. Icon. **13** (1862) *Leptopoma* pl. 4, figs. 22*a*, 22*b*.

LEPTOPOMA POECILUM Quadras and Moellendorff. MASBATE.

Nachrichbl. Malak. Ges. **27** (1895) 81.

LEPTOPOMA POLILLANUM Moellendorff. POLILLO.

Nachrichbl. Malak. Ges. **26** (1894) 110.

LEPTOPOMA PORTEI Pfeiffer. POLILLO.

Proc. Zool. Soc. London (1862) 116.

LEPTOPOMA PULCHELLUM Quadras and Moellendorff. BUSUANGA.

Nachrichbl. Malak. Ges. 26 (1894) 110.

LEPTOPOMA PULICARIUM Pfeiffer. ALABAT ISLAND.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 53, pl. 7, fig. 10.

LEPTOPOMA PUSILLUM Mollendorff. PANAY; CEBU; MINDANAO.

Abh. Naturf. Ges. 22 (1898) 143.

LEPTOPOMA PYRAMIS Kobelt. PHILIPPINES.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 33, pl. 5, figs. 3–5.

LEPTOPOMA QUADRASI Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 120, pl. 4, figs. 9, 9*a*.

LEPTOPOMA REGULARE Pfeiffer. MINDORO.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 52, pl. 7, fig. 9; Cat. Phaneropneumona Brit. Mus. (1852) 81. Conchol. Icon. 13 (1862) *Leptopoma* pl. 3, figs. 14*a*, 14*b*.

LEPTOPOMA ROSEUM Moellendorff. RIZAL.

Nachrichbl. Malak. Ges. 26 (1894) 109.

LEPTOPOMA SERICATUM Pfeiffer. PALAWAN.

Abh. Naturf. Ges. 22 (1898) 145.

LEPTOPOMA SUBALATUM Quadras and Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 179.

LEPTOPOMA SUPERBUM Dohrn. PALAWAN.

Nachrichbl. Malak. Ges. 21 (1889) 57.

LEPTOPOMA TROCHUS Dohrn. MINDANAO.

Proc. Zool. Soc. London (1862) 182; Reisen Philippinen Kobelt Landdeckelschnecken 4 (1886) 46, pl. 6, figs. 28–30.

LEPTOPOMA VARIANS Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 27 (1895) 144.

LEPTOPOMA VITREUM Lesson. LUZON; SULU ARCHIPELAGO.

Conchol. Icon. 13 (1862) *Leptopoma* pl. 3, figs. 15*a*, 15*b*; Ann. & Mag. Nat. Hist. XIII 6 (1894) 58; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 53, pl. 7, figs. 11, 12; Cat. Phaneropneumona Brit. Mus. (1852) 72; Senckenberg. Naturf. Ges. (1890) 274.

Genus LAGOCHILUS Blanford

LAGOCHILUS BALABACENSE Smith. BALABAC.

Abh. Naturf. Ges. 22 (1898) 149.

LAGOCHILUS BIFIMBRIATUM Moellendorff. MINDANAO.

Nachrichbl. Malak. Ges. 22 (1890) 208.

LAGOCHILUS BOETTGERI Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 273.

LAGOCHILUS CAGAYANICUM Quadras and Moellendorff. CAGAYAN.

Nachrichbl. Malak. Ges. 27 (1895) 80.

LAGOCHILUS CILIATUM Sowerby. LUZON.
Abh. Naturf. Ges. 22 (1898) 148. See *Leptopoma ciliatum* Sowerby.

LAGOCHILUS CONCOLOR Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 117, pl. 4, figs. 8, *8a*.

LAGOCHILUS EURYOMPHALUM Moellendorff. SAMAR.
Nachrichbl. Malak. Ges. 27 (1895) 79.

LAGOCHILUS GRADATUM Quadras and Moellendorff. BUSUANGA.
Nachrichbl. Malak. Ges. 26 (1894) 109.

LAGOCHILUS GRANDE Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 116, pl. 4, figs. 7, *7a*.

LAGOCHILUS GUIMARASENSE Sowerby. GUIMARAS; PANAY.
Abh. Naturf. Ges. 22 (1898) 149.

LAGOCHILUS MUCRONATUM Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 20 (1888) 76.

LAGOCHILUS OMPHALOTROPIS Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 148.

LAGOCHILUS PARVUM Sowerby. LEYTE; CEBU; PANAY.
Senckenberg. Naturf. Ges. (1893) 117.

LAGOCHILUS POLYTROPIS Quadras and Moellendorff. SURIGAO.
Nachrichbl. Malak. Ges. 27 (1895) 81.

LAGOCHILUS QUADRASI Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 149.

LAGOCHILUS QUINQUELIRATUS Moellendorff. SULU ARCHIPELAGO.
Ann. & Mag. Nat. Hist. XIII 6 (1894) 58, pl. 4, figs. 10, *10a*.

LAGOCHILUS SCALARE Quadras and Moellendorff. SURIGAO.
Nachrichbl. Malak. Ges. 27 (1895) 80.

LAGOCHILUS SIMILIS Smith. PALAWAN; BALABAC.
Ann. & Mag. Nat. Hist. XI 6 (1893) 352, pl. 18, figs. 14–16; Abh. Naturf. Ges. 22 (1898) 148.

LAGOCHILUS SOLIDULUM Moellendorff. BOHOL.
Nachrichbl. Malak. Ges. 26 (1894) 109.

LAGOCHILUS STENOMPHALUM Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 22 (1890) 208.

LAGOCHILUS STEPHANOPHORUM Moellendorff. CAMARINES NORTE.
Nachrichbl. Malak. Ges. 27 (1895) 143.

LAGOCHILUS SUBCARINATUM Moellendorff. CEBU.
Abh. Naturf. Ges. 22 (1898) 150.

LAGOCHILUS TIGRINULUM Moellendorff. SIQUIJOR.
Nachrichbl. Malak. Ges. 23 (1891) 50.

LAGOCHILUS TUMIDULUM Quadras and Moellendorff. NEGROS; MASBATE.
Nachrichbl. Malak. Ges. 27 (1895) 79.

LAGOCHILUS TURBINATUM Pfeiffer. BOHOL.
Abh. Naturf. Ges. 22 (1898) 148.

Genus DITROPIS Blanford

DITROPIS ADESMOSPIRA Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 141.

DITROPIS CEBUANA Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 270, pl. 9, fig. 8; Abh. Naturf. Ges. 22 (1898) 150.

DITROPIS CONULINA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 110, pl. 4, figs. 5–5*c*.

DITROPIS CORRICULUM Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 111.

DITROPIS DECOLLATA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 109, pl. 4, figs. 4–4*c*.

DITROPIS GRADATA Quadras and Moellendorff. BOHOL.

Nachrichbl. Malak. Ges. 28 (1896) 89.

DITROPIS MIRA Moellendorff. SIQUIJOR.

Nachrichbl. Malak. Ges. 23 (1891) 50.

DITROPIS PUSILLA Quadras and Moellendorff. MASBATE.

Nachrichbl. Malak. Ges. 27 (1895) 78.

DITROPIS PYRAMIDATA Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1893) 110, pl. 4, figs. 6–6*c*.

DITROPIS QUADRASI Moellendorff. MINDANAO.

Nachrichbl. Malak. Ges. 22 (1890) 207.

Genus CYCLOPHORUS Montfort

CYCLOPHORUS ACUTIMARGINATUS Sowerby. SAMAR.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 17, pl. 3, figs. 1–13.

CYCLOPHORUS ÆTARUM Moellendorff. RIZAL.

Nachrichbl. Malak. Ges. 27 (1895) 78.

CYCLOPHORUS ALABATENSIS Kobelt. ALABAT ISLAND.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 18, pl. 3, figs. 14–16.

CYCLOPHORUS APPENDICULATUS Pfeiffer. CALAYAN.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 24; Cat. Phaneropneumona Brit. Mus. (1852) 63.

CYCLOPHORUS BARANDAE Hidalgo. BATAAN.

Obras Malacológicas (1890) 18; Abh. Naturf. Ges. 22 (1898) 154.

CYCLOPHORUS BATANICUS Quadras and Moellendorff. BATAN ISLAND.

Nachrichbl. Malak. Ges. 26 (1894) 108.

CYCLOPHORUS BENGUETENSIS Hidalgo. LUZON.

Obras Malacológicas (1890) 41; Abh. Naturf. Ges. 22 (1898) 155.

CYCLOPHORUS BUSTOI Hidalgo. NEAR MINDANAO.

Obras Malacológicas (1890) 45; Abh. Naturf. Ges. 22 (1898) 156.

CYCLOPHORUS CANALIFERUS Sowerby. LUZON; MINDORO; BURIAS.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 8, figs. 31*a*, 31*b*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 23, pl. 4, figs. 12–17; Cat. Phaneropneumona Brit. Mus. (1852) 54; Abh. Naturf. Ges. 22 (1898) 152.

CYCLOPHORUS CERATODES Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 27 (1895) 142.

CYCLOPHORUS CORONENSIS Moellendorff. CORON.

Nachrichbl. Malak. Ges. 27 (1895) 78.

CYCLOPHORUS CRUENTUS Martens. SAMAR.

Ann. & Mag. Nat. Hist. XVI 3 (1865) 429; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 27; Abh. Naturf. Ges. 22 (1898) 154.

CYCLOPHORUS DARAGANICUS Hidalgo. LUZON.

Obras Malacológicas (1890) 40; Abh. Naturf. Ges. 22 (1898) 154.

CYCLOPHORUS ECTOPOMA Moellendorff. SAMAR.

Nachrichbl. Malak. Ges. 28 (1896) 88.

CYCLOPHORUS FERNANDEZI Hidalgo. MINDORO.

Obras Malacológicas (1890) 44; Abh. Naturf. Ges. 22 (1898) 156.

CYCLOPHORUS GUIMARASENSIS Sowerby. GUIMARAS.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 14, fig. 63; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 30; Cat. Phaneropneumona Brit. Mus. (1852) 51.

CYCLOPHORUS IBYATENSIS Pfeiffer. ISBAYAT ISLAND, BASHEE GROUP.

Cat. Phaneropneumona Brit. Mus. (1852) 40; Conchol. Icon. 13 (1862) *Cyclophorus* pl. 12, figs. 48*a*, 48*b*.

CYCLOPHORUS INTERCEDENS Kobelt. PHILIPPINES (?).

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 22, pl. 4, figs. 9–11.

CYCLOPHORUS LATECOSTATUS Kobelt. ZAMBOANGA.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 8, pl. 1, fig. 9. See *Platyrhaphe laticostata* Kobelt.

CYCLOPHORUS LEUCOSTOMA Pfeiffer. LEYTE; BOHOL; MINDANAO.

Senckenberg. Naturf. Ges. (1893) 114.

CYCLOPHORUS LINGUIFERUS Sowerby. BOHOL.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 15, pl. 1, figs. 3, 4; pl. 2, figs. 9, 10; Cat. Phaneropneumona Brit. Mus. (1852) 53.

CYCLOPHORUS LINGULATUS Sowerby. SIQUIJOR; CEBU; BOHOL.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 19, pl. 3, figs. 17–20; Cat. Phaneropneumona Brit. Mus. (1852) 54; Conchol. Icon. 13 (1862) *Cyclophorus* pl. 12, figs. 49*a*–49*d*; Abh. Naturf. Ges. 22 (1898) 155.

CYCLOPHORUS PALAWANENSIS Smith. PALAWAN; BALABAC.

Abh. Naturf. Ges. 22 (1898) 155.

CYCLOPHORUS PARVUS **Sowerby.** CEBU; PANAY.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 30; Cat. Phaneropneumona Brit. Mus. (1852) 59; Conchol. Icon. 13 (1862) *Cyclophorus* pl. 19, figs. 95*a*, 95*b*.

CYCLOPHORUS PHILIPPINARUM **Sowerby.** LUZON; NEGROS; SULU.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 14, figs. 64*a*, 64*b*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 27, pl. 4, figs. 24, 25; Cat. Phaneropneumona Brit. Mus. (1852) 51; Abh. Naturf. Ges. 22 (1898) 157; Ann. & Mag. Nat. Hist. XIII 6 (1894) 57.

CYCLOPHORUS PICTURATUS **Pfeiffer.** MINDANAO.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 6, figs. 22*a*, 22*b*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 29.

CYCLOPHORUS PLATENI **Dohrn.** PALAWAN.

Nachrichbl. Malak. Ges. 21 (1889) 55.

CYCLOPHORUS PRIETOI **Hidalgo.** CATANDUANES.

Obras Malacológicas (1893) 43; Abh. Naturf. Ges. 22 (1898) 154.

CYCLOPHORUS PTEROCYCLUS **Moellendorff.** CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 142.

CYCLOPHORUS PUNCTATUS **Grateloup.** BASILAN.

Cat. Phaneropneumona Brit. Mus. (1852) 45; Conchol. Icon. 13 (1862) *Cyclophorus* pl. 12, figs. 51*a*, 51*b*.

CYCLOPHORUS QUADRASI **Hidalgo.** PALAWAN.

Obras Malacológicas (1890) 42; Abh. Naturf. Ges. 22 (1898) 151.

CYCLOPHORUS REEVEI **Hidalgo.** LUBANG; TABLAS.

Obras Malacológicas (1890) 47; Abh. Naturf. Ges. 22 (1898) 157.

CYCLOPHORUS SEMPERI **Kobelt.** CEBU.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 25, pl. 2, figs. 14, 15.

CYCLOPHORUS SERICINUS **Quadras and Moellendorff.** BUSUANGA.

Nachrichbl. Malak. Ges. 26 (1894) 108.

CYCLOPHORUS SMITHI **Hidalgo.** BUSUANGA.

Obras Malacológicas (1890) 55; Abh. Naturf. Ges. 22 (1898) 151.

CYCLOPHORUS SOWERBYI **Hidalgo.** LUZON; MASBATE; BOHOL; LEYTE.

Obras Malacológicas (1890) 46; Senckenberg. Naturf. Ges. (1893) 116; Abh. Naturf. Ges. 22 (1898) 157.

CYCLOPHORUS TELIFER **Moellendorff.** TAYABAS.

Nachrichbl. Malak. Ges. 21 (1889) 107.

CYCLOPHORUS THERSITES **Shuttleworth.** PHILIPPINES.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 28.

CYCLOPHORUS TIGRINUS **Sowerby.** PHILIPPINES.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 6, figs. 25*a*, 25*b*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 16, pl. 2, figs. 21–23; pl. 2, figs. 6–8; Cat. Phaneropneumona Brit. Mus. (1852) 49; Abh. Naturf. Ges. 22 (1898) 154.

CYCLOPHORUS TROCHIFORMIS Kobelt. BOHOL.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 25, pl. 4, figs. 20, 21.

CYCLOPHORUS TURBINATUS Pfeiffer. BOHOL.

Cat. Phaneropneumona Brit. Mus. (1852) 52; Conchol. Icon. 13 (1862) *Cyclophorus* pl. 14, fig. 61.

CYCLOPHORUS TURGIDUS Pfeiffer. BATANES (?).

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 11, figs. 43*a*, 43*b*.

CYCLOPHORUS UMBILICATUS Kobelt. PHILIPPINES (?).

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 26, pl. 4, figs. 22, 23.

CYCLOPHORUS VALIDUS Sowerby. LUZON; LEYTE; SAMAR; MINDANAO.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 6, figs. 33*a*–33*b*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 14, pl. 1, figs. 1, 2; pl. 2, figs. 1–5; Cat. Phaneropneumona Brit. Mus. (1852) 52; Abh. Naturf. Ges. 22 (1898) 153.

CYCLOPHORUS WOODIANUS Lea. LUZON.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 18, figs. 33*a*, 33*b*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 20, pl. 4, figs. 1–8; Cat. Phaneropneumona Brit. Mus. (1852) 61; Abh. Naturf. Ges. 22 (1898) 151.

CYCLOPHORUS ZEBRA Grateloup. MOUNT ARAYAT, PAMPANGA.

Conchol. Icon. 13 (1862) *Cyclophorus* pl. 14, fig. 65; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 26, pl. 4, figs. 18, 19; Cat. Phaneropneumona Brit. Mus. (1852) 50. See *Cyclophorus philippinarum* Sowerby.

Genus PLATYRHAPHE Moellendorff

PLATYRHAPHE ANOCAMPTA Moellendorff. SAMAR.

Abh. Naturf. Ges. 22 (1898) 158.

PLATYRHAPHE ANTHOPOMA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 27 (1895) 81.

PLATYRHAPHE COPTOLOMA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 178.

PLATYRHAPHE EURYSTOMA Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 159.

PLATYRHAPHE EXPANSILABRIS Moellendorff. BUSUANGA.

Nachrichbl. Malak. Ges. 29 (1897) 37.

PLATYRHAPHE LATECOSTATA Kobelt. CEBU; MINDANAO.

Abh. Naturf. Ges. 22 (1898) 157.

PLATYRHAPHE LATEPLICATA Moellendorff. TABLAS.

Abh. Naturf. Ges. 22 (1898) 158.

PLATYRHAPHE MAMMILLATA Quadras and Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 159.

PLATYRHAPHE MUCRONATA Sowerby. LUZON.
Abh. Naturf. Ges. 22 (1898) 159.

PLATYRHAPHE PLEBEJA Sowerby. LUZON; MARINDUQUE; CATANDUANES.
Abh. Naturf. Ges. 22 (1898) 159.

PLATYRHAPHE PUSILLA Sowerby. LUZON; CEBU; BOHOL.
Abh. Naturf. Ges. 22 (1898) 157.

PLATYRHAPHE QUADRASI Hidalgo. CATANDUANES.
Abh. Naturf. Ges. 22 (1898) 159.

PLATYRHAPHE SCALARIS Pfeiffer. PHILIPPINES.
Abh. Naturf. Ges. 22 (1898) 158.

PLATYRHAPHE SORDIDA Pfeiffer. MINDORO; CALAMIANES; PALAWAN.
Abh. Naturf. Ges. 22 (1898) 158.

PLATYRHAPHE SUBSTRIATA Sowerby. SIQUIJOR.
Abh. Naturf. Ges. 22 (1898) 158.

Genus CYCLOTUS Guilding

CYCLOTUS ANOCAMPTUS Moellendorff. SAMAR.
Nachrichbl. Malak. Ges. 27 (1895) 82. See *Platyrhaphe anocampta* Moellendorff.

CYCLOTUS ANTHOPOMA Moellendorff. RIZAL; BULACAN.
Nachrichbl. Malak. Ges. 27 (1895) 81. See *Platyrhaphe anthopoma* Moellendorff.

CYCLOTUS AURICULATUS Kobelt. SURIGAO.
Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 6, pl. 1, fig. 6.

CYCLOTUS BONGAOENSIS Smith. BONGAO, SULU ARCHIPELAGO.
Ann. & Mag. Nat. Hist. XIII 6 (1894) 57, pl. 4, figs. 8, 8*a*.

CYCLOTUS CAROLI Kobelt. LEYTE.
Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 8, pl. 1, fig. 8; Abh. Naturf. Ges. 22 (1898) 160.

CYCLOTUS CYCLOPHOROIDES Moellendorff. CEBU.
Senckenberg. Naturf. Ges. (1890) 269, pl. 10, fig. 7; Abh. Naturf. Ges. 22 (1898) 159.

CYCLOTUS EURYSTOMA Moellendorff. RIZAL.
Nachrichbl. Malak. Ges. 26 (1894) 107. See *Platyrhaphe eurystoma* Moellendorff.

CYCLOTUS EUZONUS Dohrn. PALAWAN.
Ann. & Mag. Nat. Hist. XI 6 (1893) 353, pl. 18, figs. 17–19.

CYCLOTUS GRADATUS Moellendorff. CORON.
Nachrichbl. Malak. Ges. 26 (1894) 108.

CYCLOTUS LATEPLICATUS Moellendorff. TABLAS.
Nachrichbl. Malak. Ges. 28 (1896) 13. See *Platyrhaphe lateplicata* Moellendorff.

CYCLOTUS LEYTENSIS Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 106, pl. 4, figs. *3a–3c*.

CYCLOTUS MINDORICUS Quadras and Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. 28 (1896) 88.

CYCLOTUS MUCRONATUS Sowerby. LUZON.

Conchol. Icon. 14 (1864) *Cyclotus* pl. 5, fig. 27; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 7, pl. 1, fig. 7; Cat Phaneropneumona Brit. Mus. (1852) 22. See *Platyrhaphe mucronata* Sowerby.

CYCLOTUS PLEBEJUS Sowerby. LAGUNA.

Conchol. Icon. 14 (1864) *Cyclotus* pl. 9, fig. 55; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 10. See *Platyrhaphe plebeja* Sowerby.

CYCLOTUS PUSILLUS Sowerby. LUZON; NEGROS.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 9, pl. 2, figs. 16, 17; Cat. Phaneropneumona Brit. Mus. (1852) 20; Conchol. Icon. 14 (1864) *Cyclotus* pl. 7, fig. 39. See *Platyrhaphe pusilla* Sowerby.

CYCLOTUS SCALARIS Pfeiffer. PHILIPPINES.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 10; Cat. Phaneropneumona Brit. Mus. (1852) 20; Conchol. Icon. 14 (1864) *Cyclotus* pl. 9, fig. 51. See *Platyrhaphe scalaris* Pfeiffer.

CYCLOTUS SUBSTRIATUS Sowerby. SIQUIJOR.

Cat. Phaneropneumona Brit. Mus. (1852) 22; Conchol. Icon. 14 (1864) *Cyclotus* pl. 5, fig. 22. See *Platyrhaphe substriata* Sowerby.

CYCLOTUS SULCATUS Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 268, pl. 9, fig. 6; Abh. Naturf. Ges. 22 (1898) 160.

CYCLOTUS SULUANUS Moellendorff. SULU ARCHIPELAGO.

Ann. & Mag. Nat. Hist. XIII 6 (1894) 56, pl. 4, fig. 7.

CYCLOTUS VARIEGATUS Swainson. PANAY; SULU ARCHIPELAGO.

Conchol. Icon. 14 (1864) *Cyclotus* pl. 6, figs. *29a*, *29b*; Ann. & Mag. Nat. Hist. XII 6 (1894) 57; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 5, pl. 1, fig. 5; Cat. Phaneropneumona Brit. Mus. (1852) 23.

Genus OPISTHOPORUS Benson

OPISTHOPORUS QUADRASI Hidalgo. CALAMIANES; PALAWAN; BALABAC.

Ann. & Mag. Nat. Hist. XI 6 (1893) 351; Abh. Naturf. Ges. 22 (1898) 160.

Genus CYATHOPOMA Blanford

CYATHOPOMA ARIES Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 265, pl. 9, fig. 5. See *Heteropoma aries* Moellendorff.

CYATHOPOMA MERIDIONALE Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 265. See *Heteropoma meridionale* Moellendorff.

CYATHOPOMA PYRAMIDATUM Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 106, pl. 4, figs. 2–26. See *Heteropoma pyramidatum* Moellendorff.

Genus MEGALOMASTOMA Guilding

MEGALOMASTOMA ALTUM Sowerby. NEGROS.

Thesaurus Conchyl. 3 (1866) 263, pl. 1, fig. 23; Conchol. Icon. 20 (1878) *Megalomastoma* pl. 9, fig. 86; Cat. Phaneropneumona Brit. Mus. (1852) 93. See *Schistoloma alta* Sowerby.

MEGALOMASTOMA QUADRASI Hidalgo. BUSUANGA.

Obras Malacológicas (1890) 56. See *Schistoloma quadrasi* Hidalgo.

Genus SCHISTOLOMA Kobelt

(*Coptocheilus* Gould)

SCHISTOLOMA ALTA Sowerby. NEGROS.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 59; Proc. U. S. Nat. Mus. 49 (1915) 197, many figures.

SCHISTOLOMA MCGREGORI Bartsch. MINDORO; SEMERARA; TABLAS.

Proc. U. S. Nat. Mus. 37 (1909) 298, pl. 29, fig. 15; 45 (1915) 200, pl. 51, figs. 2, 4.

SCHISTOLOMA QUADRASI Hidalgo. BUSUANGA; CORON.

Abh. Naturf. Ges. 22 (1898) 161; Proc. U. S. Nat. Mus. 45 (1915) 203; pl. 51, figs. 8, 10. See *Megalomastoma quadrasi* Hidalgo.

Genus PUPINELLA Gray

PUPINELLA MINDORENSIS Adams and Reeve. MINDORO.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 61.

PUPINELLA PUPINIFORMIS Sowerby. CAGAYAN.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 60, pl. 7, figs. 17, 18; Cat. Phaneropneumona Brit. Mus. (1852) 98.

PUPINELLA QUADRASI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 179.

Genus PUPINA Vignard

PUPINA BICANALICULATA Sowerby. CEBU.

Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 62; Cat. Phaneropneumona Brit. Mus. (1852) 101; Proc. Zool. Soc. London (1841) 103; Conchol. Icon. 20 (1878) *Pupina* pl. 2, fig. 11; Thesaurus Conchyl. 1 (1847) 19, pl. 4, fig. 1, 3 (1866) 265, pl. 3, figs. 12, 13.

PUPINA CALAMIANICA Quadras and Moellendorff. BUSUANGA.

Nachrichbl. Malak. Ges. 26 (1894) 116.

PUPINA EXIGUA Sowerby. CEBU.

Proc. Zool. Soc. London (1841) 103; Thesaurus Conchyl. 1 (1847) 18, pl. 4, fig. 17. See *Moulinsia exigua* Sowerby.

PUPINA GRACILIS Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 278; Abh. Naturf. Ges. (1898) 162.

PUPINA HYPTIOSTOMA Quadras and Moellendorff. SIBUYAN; TABLAS; ROMBLON.

Nachrichbl. Malak. Ges. 26 (1894) 117.

PUPINA JOSEPHI Moellendorff. BALABAC.

Nachrichbl. Malak. Ges. 26 (1894) 116.

PUPINA KERAUDRENII Vignard. MANILA.

Proc. Zool. Soc. London (1841) 103; Thesaurus Conchyl. 1 (1847) 19, pl. 4, fig. 27.

PUPINA LUBRICA Sowerby. LUZON; PANAY; SIQUIJOR.

Proc. Zool. Soc. London (1841) 102; Thesaurus Conchyl. 1 (1847) 18, pl. 4, figs. 12–16. See *Callia lubrica* Sowerby.

PUPINA MINDORENSIS Adams and Reeve. MINDORO.

Cat. Phaneropneumona Brit. Mus. (1852) 99 H. M. S. Samarang Voy. Zool. Publ. London (1850) 57, pl. 14, fig. 2. See *Pupinella mindorensis* Adams and Reeve.

PUPINA NANA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 131, pl. 5, figs. 8–8c.

PUPINA NUNEZII Grateloup. CATANDUANES; SAMAR; SIQUIJOR.

Proc. Zool. Soc. London (1841) 101; Thesaurus Conchyl. 1 (1847) 17, pl. 4, figs. 8–11.

PUPINA OTTONIS Dohrn. BATAAN; SULU.

Proc. Zool. Soc. London (1862) 183; Thesaurus Conchyl. 3 (1866) pl. 3, fig. 25; Conchol. Icon. 20 (1878) *Pupina* pl. 3, fig. 25; Ann. & Mag. Nat. Hist. XIII 6 (1894) 58; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 61, pl. 7, fig. 19.

PUPINA PELLUCIDA Sowerby. LUZON; CEBU.

Proc. Zool. Soc. London (1841) 102; Thesaurus Conchyl. 1 (1847) 17, pl. 4, figs. 18–20. See *Moulinsia pellucida* Sowerby.

PUPINA PUPINAEFORMIS Sowerby. PHILIPPINES.

Conchol. Icon. 20 (1878) *Pupina* pl. 2, fig. 20; Theasurus Conchyl. 3 (1866) pl. 3, figs. 38, 39.

PUPINA QUADRASI Moellendorff. LUBANG ISLAND.

Nachrichbl. Malak. Ges. 26 (1894) 118.

PUPINA SIMILIS Sowerby. ZAMBALES.

Proc. Zool. Soc. London (1841) 102; Thesaurus Conchyl. 1 (1847) 18, pl. 4, figs. 4, 5. See *Moulinsia similis* Sowerby.

PUPINA SPECTABILIS Quadras and Moellendorff. BUSUANGA.

Nachrichbl. Malak. Ges. 26 (1894) 116.

PUPINA STRIATELLA Quadras and Moellendorff. MINDORO.

Nachrichbl. Malak. Ges. 26 (1894) 117.

PUPINA VITREA Sowerby. ALBAY; MISAMIS.

Proc. Zool. Soc. London (1841) 102; Thesaurus Conchyl. 1 (1847) 18, pl. 4, figs. 6, 7. See *Moulinsia vitrea* Sowerby.

Genus HARGRAVESIA H. Adams

HARGRAVESIA LUZONICA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 29 (1897) 39.

HARGRAVESIA PHILIPPINICA Moellendorff. SIQUIJOR.

Nachrichbl. Malak. Ges. 23 (1891) 51.

Genus MOULINSIA Grateloup

(*Registoma* Hasselt)

MOULINSIA AMBIGUA Semper. LUZON.

Proc. Zool. Soc. London (1864) 251; Thesaurus Conchyl. 3 (1866) pl. 2, fig. 9; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 66, pl. 7, figs. 20, 21. See *Porocallia ambigua* Semper.

MOULINSIA DISSIMILIS Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 29 (1897) 40.

MOULINSIA EXIGUA Sowerby. LUZON; CEBU.

Thesaurus Conchyl. 3 (1866) pl. 2, fig. 8; Conchol. Icon. 20 (1878) *Pupinidæ* pl. 5, fig. 39; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 67; Cat. Phaneropneumona Brit. Mus. (1852) 104. See *Pupina exigua* Sowerby.

MOULINSIA FUSCA Gray. LUZON; CEBU; BOHOL; MINDANAO.

Thesaurus Conchyl. 3 (1866) pl. 2, figs. 4, 5; Conchol. Icon. 20 (1878) *Pupinidæ* pl. 5, fig. 43; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 65; Cat. Phaneropneumona Brit. Mus. (1852) 103; Senckenberg. Naturf. Ges. (1893) 134.

MOULINSIA GRANDIS Gray. LUZON; SIQUIJOR; SAMAR; MINDANAO.

Thesaurus Conchyl. 3 (1866) pl. 2, figs. 1–3; Conchol. Icon. 20 (1878) *Pupinidæ* pl. 5, figs. 42*a*–42*c*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 65; Cat. Phaneropneumona Brit. Mus. (1852) 102; Senckenberg. Naturf. Ges. (1893) 132.

MOULINSIA PELLUCIDA Sowerby. LUZON; CEBU.

Thesaurus Conchyl. 3 (1866) pl. 2, figs. 10, 11; Conchol. Icon. 20 (1878) *Pupinidæ* pl. 5, figs. 45*a*–45*b*; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 67; Cat. Phaneropneumona Brit. Mus. (1852) 102. See *Pupina pellucida* Sowerby.

MOULINSIA PEREXIGUA Quadras and Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 26 (1894) 118.

MOULINSIA PEROBLIQUA Quadras and Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 26 (1894) 119.

MOULINSIA QUADRASI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 180.

MOULINSIA SEMISCISSA Quadras and Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 26 (1894) 119.

MOULINSIA SEMPERI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. **29** (1897) 40.

MOULINSIA SIMILIS Sowerby. ZAMBALES.

Thesaurus Conchyl. **3** (1866) pl. 2, fig. 6; Conchol. Icon. **20** (1878) *Pupinidæ* pl. 5, fig. 44; Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 68; Cat. Phaneropneumona Brit. Mus. (1852) 103. See *Pupina similis* Sowerby.

MOULINSIA STREPTAXIS Moellendorff. RIZAL.

Nachrichbl. Malak. Ges. **26** (1894) 118.

MOULINSIA VITREA Sowerby. LUZON.

Registoma vitreum SOWERBY, Conchol. Icon. **20** (1878) *Registoma* pl. 5, fig. 40. See *Pupina vitrea* Sowerby.

Genus POROCALLIA Moellendorff

POROCALLIA AMBIGUA Semper. LUZON.

Abh. Naturf. Ges. **22** (1898) 164. See *Callia ambigua* Semper.

POROCALLIA CANALIFERA Quadras and Moellendorff. CATANDUANES.

Nachrichbl. Malak. Ges. **27** (1895) 83.

POROCALLIA MICROSTOMA Kobelt. MINDANAO.

Senckenberg. Naturf. Ges. (1893) 134. See *Callia microstoma* Kobelt.

Genus CALLIA Gray

CALLIA AMBIGUA Semper. LUZON.

Conchol. Icon. **20** (1878) *Pupinidæ* pl. 4, fig. 37. See *Moulinsia ambigua* Semper, *Porocallia ambigua* Semper.

CALLIA LUBRICA Sowerby. LUZON; PANAY; SIQUIJOR.

Thesaurus Conchyl. **3** (1866) pl. 3, figs. 1–4; Conchol. Icon. **20** (1878) *Pupinidæ* pl. 4, figs. 34*a*, 34*b*; Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 63; Cat. Phaneropneumona Brit. Mus. (1852) 105. See *Pupina lubrica* Sowerby.

CALLIA MICROSTOMA Kobelt. MINDANAO.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 64; pl. 7, fig. 22. See *Porocallia microstoma* Kobelt.

Genus ALYCAEUS Gray

ALYCAEUS CAROLI Semper. LUZON.

Reisen Philippinen, Kobelt Landdeckelschnecken **4** (1886) 11, pl. 1, fig. 15.

ALYCAEUS CYPHOGYRUS Quadras and Moellendorff. LUZON; CATANDUANES.

Nachrichbl. Malak. Ges. **27** (1895) 144.

ALYCAEUS EXCISUS Moellendorff. SULU ARCHIPELAGO.

Ann. & Mag. Nat. Hist. XII **6** (1894) 57.

ALYCAEUS QUADRASI Moellendorff. CAGAYAN.

Nachrichbl. Malak. Ges. **27** (1895) 83.

ALYCAEUS TOMOTREMA Moellendorff. LUZON.

Abh. Naturf. Ges. **22** (1898) 165.

Genus HELICOMORPHA Moellendorff

HELICOMORPHA APPENDICULATA Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 122, pl. 4, figs. 11–11*b*.

HELICOMORPHA CONELLA Moellendorff. GUIMARAS.
Nachrichbl. Malak. Ges. 26 (1894) 111.

HELICOMORPHA COSTULATA Quadras and Moellendorff. BUSUANGA.
Nachrichbl. Malak. Ges. 26 (1894) 111.

HELICOMORPHA DEPRESSA Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 123, pl. 4, figs. 12–12*b*.

HELICOMORPHA GLOBULUS Quadras and Moellendorff. BUSUANGA.
Nachrichbl. Malak. Ges. 27 (1895) 84.

HELICOMORPHA LINGUIFERA Quadras and Moellendorff. BOHOL.
Nachrichbl. Malak. Ges. 28 (1896) 90.

HELICOMORPHA PILULA Quadras and Moellendorff. BOHOL.
Nachrichbl. Malak. Ges. 28 (1896) 90.

HELICOMORPHA QUADRASI Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 121, pl. 4, figs. 10–10*b*.

HELICOMORPHA TURRICULA Moellendorff. CEBU.
Senckenberg. Naturf. Ges. (1890) 280, pl. 9, fig. 9; Abh. Naturf. Ges. 22 (1898) 166.

Genus DIPLOMMATINA Benson

DIPLOMMATINA ACULUS Moellendorff. MARINDUQUE.
Nachrichbl. Malak. Ges. 26 (1894) 113.

DIPLOMMATINA BALERICA Quadras and Moellendorff. TABLAS.
Nachrichbl. Malak. Ges. 28 (1896) 14.

DIPLOMMATINA BICOLOR Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 175.

DIPLOMMATINA BISLIGENSIS Moellendorff. MINDANAO.
Abh. Naturf. Ges. 22 (1898) 174.

DIPLOMMATINA BOETTGERI Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 174.

DIPLOMMATINA BOHOLENSIS Quadras and Moellendorff. BOHOL.
Nachrichbl. Malak. Ges. 28 (1896) 91.

DIPLOMMATINA BREVIPLICA Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 129, pl. 5, figs. 5–5*b*.

DIPLOMMATINA CAGAYANICA Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 182.

DIPLOMMATINA CEBUENSIS Moellendorff. NEGROS; CEBU; BOHOL.
Senckenberg. Naturf. Ges. (1890) 285; Abh. Naturf. Ges. 22 (1898) 171.

DIPLOMMATINA CONCAVOSPIRA Moellendorff. RIZAL.
Nachrichbl. Malak. Ges. 26 (1894) 115.

DIPLOMMATINA CONCOLOR Quadras and Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 182.

DIPLOMMATINA CRYSTALLODES Quadras and Moellendorff. BOHOL.
Nachrichbl. Malak. Ges. 28 (1896) 92.

DIPLOMMATINA CYRTOCHILUS Quadras and Moellendorff. BUSUANGA.
Nachrichbl. Malak. Ges. 27 (1895) 87.

DIPLOMMATINA DECIPIENS Moellendorff. CEBU.
Abh. Naturf. Ges. 22 (1898) 174.

DIPLOMMATINA DIPLOLOMA Quadras and Moellendorff. SURIGAO.
Nachrichbl. Malak. Ges. 27 (1895) 87.

DIPLOMMATINA ELEGANS Moellendorff. CEBU.
Senckenberg. Naturf. Ges. (1890) 286; Abh. Naturf. Ges. 22 (1898) 171.

DIPLOMMATINA ELEGANTISSIMA Quadras and Moellendorff. SIQUIJOR.
Nachrichbl. Malak. Ges. 27 (1895) 86.

DIPLOMMATINA ELISABETHAE Moellendorff. LUZON; CATANDUANES; GUIMARAS.
Abh. Naturf. Ges. 22 (1898) 174.

DIPLOMMATINA FILICOSTATA Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 182.

DIPLOMMATINA FIMBRIOSA Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 20 (1888) 77.

DIPLOMMATINA GONIOCAMPTA Quadras and Moellendorff. SURIGAO.
Nachrichbl. Malak. Ges. 27 (1895) 86.

DIPLOMMATINA GONOSTOMA Moellendorff. GUIMARAS.
Nachrichbl. Malak. Ges. 26 (1894) 113.

DIPLOMMATINA HELISCUS Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 27 (1895) 147.

DIPLOMMATINA IRREGULARIS Moellendorff. LEYTE; CEBU.
Senckenberg. Naturf. Ges. (1893) 131; Abh. Naturf. Ges. 22 (1898) 175.

DIPLOMMATINA KOCHIANA Moellendorff. CEBU.
Abh. Naturf. Ges. 22 (1898) 173.

DIPLOMMATINA LATILABRIS Semper. LUZON.
Reisen Philippinen Kobelt Landdeckelschnecken 4 (1886) 77, pl. 7, fig. 23.

DIPLOMMATINA LEPTOSPIRA Moellendorff. BOHOL.
Nachrichbl. Malak. Ges. 29 (1897) 45.

DIPLOMMATINA LEYTENSIS Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 128, pl. 5, figs. 4–4*b*.

DIPLOMMATINA MASBATICA Quadras and Moellendorff. MASBATE.
Nachrichbl. Malak. Ges. 27 (1895) 85.

DIPLOMMATINA MEGALOPTYX Moellendorff. SIBUL, BULACAN.
Nachrichbl. Malak. Ges. 26 (1894) 115.

DIPLOMMATINA MICROPLEURIS Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 130, pl. 5, figs. 6–6*b*.

DIPLOMMATINA MICROSTOMA Moellendorff. CEBU.

Abh. Naturf. Ges. 22 (1898) 174.

DIPLOMMATINA MINDANAVICA Quadras and Moellendorff. SURIGAO.

Nachrichbl. Malak. Ges. 27 (1895) 87.

DIPLOMMATINA NODIFERA Moellendorff. SIQUIJOR.

Nachrichbl. Malak. Ges. 23 (1891) 54.

DIPLOMMATINA OLIGOGYRA Moellendorff. CORON.

Nachrichbl. Malak. Ges. 26 (1894) 114.

DIPLOMMATINA OOSTOMA Moellendorff. MINDANAO.

Nachrichbl. Malak. Ges. 26 (1894) 115.

DIPLOMMATINA PALATALIS Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 176.

DIPLOMMATINA PERPUSILLA Quadras and Moellendorff. NEGROS.

Abh. Naturf. Ges. 22 (1898) 173.

DIPLOMMATINA PIMELODES Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 286, pl. 9, fig. 11; Abh. Naturf. Ges. 22 (1898) 172.

DIPLOMMATINA PROSTRATA Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 26 (1894) 113.

DIPLOMMATINA QUADRASI Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 128, pl. 5, figs. 3–3*b*.

DIPLOMMATINA ROEBELENI Moellendorff. SIQUIJOR; SULU.

Ann. & Mag. Nat. Hist. XIII 6 (1894) 58, pl. 4, figs. 11, 11*a*; Abh. Naturf. Ges. 22 (1898) 171.

DIPLOMMATINA RUBELLA Moellendorff. NEGROS.

Nachrichbl. Malak. Ges. 26 (1894) 114.

DIPLOMMATINA RUPICOLA Moellendorff. CEBU; LEYTE.

Senckenberg. Naturf. Ges. (1890) 287; (1893) 127; Abh. Naturf. Ges. 22 (1898) 172.

DIPLOMMATINA SCHADENBERGI Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 172.

DIPLOMMATINA ? SOWERBYI Pfeiffer. PANAY; CEBU.

Cat. Phaneropneumona Brit. Mus. (1852) 84.

DIPLOMMATINA SUBCALCARATA Moellendorff. SAMAL.

Nachrichbl. Malak. Ges. 26 (1894) 114.

DIPLOMMATINA SUBCRYSTALLINA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 130, pl. 5, figs. 7–7*b*.

DIPLOMMATINA SUBFUSIFORMIS Moellendorff. SIQUIJOR; BOHOL.

Nachrichbl. Malak. Ges. 23 (1891) 55; Abh. Naturf. Ges. 22 (1898) 174.

DIPLOMMATINA TABLASENSIS Hidalgo. TABLAS.
Obras Malacológicas (1890) 39.

DIPLOMMATINA THERSITES Moellendorff. CEBU.
Senckenberg. Naturf. Ges. (1890) 288, pl. 9, fig. 12, Abh. Naturf. Ges. 22 (1898) 176.

DIPLOMMATINA TURRITELLA Moellendorff. RIZAL.
Nachrichbl. Malak. Ges. 26 (1894) 113.

DIPLOMMATINA VENTROSULA Quadras and Moellendorff. BOHOL.
Abh. Naturf. Ges. 22 (1898) 174.

DIPLOMMATINA VESICANS Moellendorff. SIQUIJOR.
Nachrichbl. Malak. Ges. 23 (1891) 56.

Genus PALAINA Semper

PALAINA CATANDUANICA Quadras and Moellendorff. CATANDUANES.
Nachrichbl. Malak. Ges. 27 (1895) 85.

PALAINA CHALAROSTOMA Moellendorff. TAYABAS.
Nachrichbl. Malak. Ges. 28 (1896) 13.

PALAINA CHRYSALIS Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 125.

PALAINA CONSPICUA Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 180.

PALAINA CRISTATA Quadras and Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 181.

PALAINA DEFORMIS Quadras and Moellendorff. CATANDUANES.
Nachrichbl. Malak. Ges. 27 (1895) 85.

PALAINA HIDALGOI Quadras and Moellendorff. BOHOL.
Revista Real Academia de Ciencias, Madrid II 22 (1925) 171, fig. 7; Nachrichbl. Malak. Ges. 28 (1896) 91.

PALAINA MIRABILIS Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 127, pl. 5, figs. 2–2*c*.

PALAINA MODESTA Quadras and Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 25 (1893) 181.

PALAINA MORONGENSIS Moellendorff. LUZON.
Nachrichbl. Malak. Ges. 22 (1890) 208.

PALAINA PORRECTA Moellendorff. LEYTE.
Senckenberg. Naturf. Ges. (1893) 126, pl. 5, figs. 1–1*b*; Abh. Naturf. Ges. 22 (1898) 170.

PALAINA QUADRASI Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 169.

PALAINA SAXICOLA Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 169.

PALAINA TRACHELOSTOPHA Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 285, pl. 9, fig. 10; Abh. Naturf. Ges. 22 (1898) 170.

PALAINA ULINGENSIS Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 284; Abh. Naturf. Ges. 22 (1898) 170.

Genus DIANCTA Martens

DIANCTA PHILIPPINICA Quadras and Moellendorff. SIQUIJOR.

Nachrichbl. Malak. Ges. 27 (1895) 88.

Genus ARINIA H. and A. Adams

ARINIA CALATHISCUS Quadras and Moellendorff. NEGROS.

Nachrichbl. Malak. Ges. 27 (1895) 84.

ARINIA CHRYSACME Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 145.

ARINIA CONTRACTA Quadras and Moellendorff. SURIGAO.

Nachrichbl. Malak. Ges. 27 (1895) 84.

ARINIA COSTATA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 125.

ARINIA CUSPIDATA Moellendorff. CORON.

Nachrichbl. Malak. Ges. 26 (1894) 111.

ARINIA DEVIANS Moellendorff. LEYTE; CEBU; NEGROS.

Senckenberg. Naturf. Ges. (1893) 124, Abh. Naturf. Ges. 22 (1898) 168.

ARINIA DICHROA Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 145.

ARINIA GIBBOSULA Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 146.

ARINIA HOLOPLEURIS Moellendorff. CEBU.

Senckenberg. Naturf. Ges. (1890) 282; Abh. Naturf. Ges. 22 (1898) 167.

ARINIA MANOPLEURIS Quadras and Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 28 (1896) 91.

ARINIA MINOR Sowerby. PANAY; CEBU; LEYTE.

Thesaurus Conchyl. 3 (1866) pl. 2, fig. 1; Conchol. Icon. 20 (1878) *Pupinidæ* pl. 7, fig. 66; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 12, pl. 1, fig. 13; Abh. Naturf. Ges. 22 (1898) 166.

ARINIA MINUTIOR Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 26 (1894) 112.

ARINIA MINUTISSIMA Moellendorff. NEGROS; CEBU; BOHOL; LEYTE.

Senckenberg. Naturf. Ges. (1893) 124; Abh. Naturf. Ges. 22 (1898) 168.

ARINIA OVULUM Moellendorff. SIBUYAN.

Nachrichbl. Malak. Ges. 28 (1896) 13.

ARINIA PALLIDA Moellendorff. BENGUET.

Nachrichbl. Malak. Ges. 28 (1896) 90.

ARINIA PLAGIOSTOMA Moellendorff. SAMAL ISLAND.

Nachrichbl. Malak. Ges. 26 (1894) 112.

ARINIA SCALATELLA Dohrn. LUZON.

Proc. Zool. Soc. London (1862) 184; Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 12, pl. 1, fig. 14.

ARINIA SINULABRIS Moellendorff. SAMAL ISLAND.

Nachrichbl. Malak. Ges. 26 (1894) 112.

ARINIA SOWERBYI Pfeiffer. LEYTE; CEBU.

Senckenberg. Naturf. Ges. (1890) 282; (1893) 124.

ARINIA TABLASENSIS Hidalgo. TABLAS.

Abh. Naturf. Ges. 22 (1898) 167.

Family REALIIDÆ

Genus OMPHALOTROPIS Pfeiffer

OMPHALOTROPIS COLUMELLARIS Quadras and Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 183.

OMPHALOTROPIS CONJUNGENS Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 136, pl. 5, figs. 9–9*b*.

OMPHALOTROPIS DENSELIRATA Quadras and Moellendorff. CULION.

Nachrichbl. Malak. Ges. 26 (1894) 119.

OMPHALOTROPIS FILOCINCTA Quadras and Moellendorff. ISABELA.

Nachrichbl. Malak. Ges. 28 (1896) 14.

OMPHALOTROPIS GRADATA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 27 (1895) 148.

OMPHALOTROPIS POLITA Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 178.

OMPHALOTROPIS PUSILLA Quadras and Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 27 (1895) 148.

OMPHALOTROPIS SEMPERI Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 183.

OMPHALOTROPIS TROCHOMORPHA Moellendorff. CEBU; MINDANAO; SAMAR.

Abh. Naturf. Ges. 22 (1898) 177. See *Ganesella trocomorpha* Moellendorff.

Genus ACMELLA Blanford

ACMELLA HUNGERFORDIANA Nevill. LEYTE; CEBU; NEGROS.

Senckenberg. Naturf. Ges. (1890) 289; (1893) 135.

Genus HETEROPOMA Moellendorff

HETEROPOMA ARIES Moellendorff. CEBU.
Abh. Naturf. Ges. 22 (1898) 179.

HETEROPOMA CONCAUOSPIRUM Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 178.

HETEROPOMA CORNU Moellendorff. SIQUIJOR.
Abh. Naturf. Ges. 22 (1898) 179.

HETEROPOMA EUSPIRUM Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 178.

HETEROPOMA MERIDIONALE Moellendorff. CEBU.
Abh. Naturf. Ges. 22 (1898) 178.

HETEROPOMA MICROCONUS Quadras and Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 178.

HETEROPOMA PHILIPPINENSE Moellendorff. LUZON.
Abh. Naturf. Ges. 22 (1898) 178.

HETEROPOMA PYRAMIDATUM Moellendorff. CATANDUANES; LEYTE; BOHOL.
Abh. Naturf. Ges. 22 (1898) 178.

Family HELICINIDÆ

Genus GEOPHORUS Fischer

GEOPHORUS ACUTA Pfeiffer. CEBU; SAMAR; MINDANAO.
Helicina acuta PFEIFFER, Proc. Zool. Soc. London (1848) 119, Kobelt Landdeckelschnecken 4 (1886) 73, pl. 7, fig. 31; Cat. Phaneropneumona Brit. Mus. (1852) 289; Senckenberg. Naturf. Ges. (1890) 290; (1893) 139.

GEOPHORUS ACUTISSIMA Sowerby. LEYTE; BOHOL; NEGROS.
Helicina acutissima SOWERBY, Proc. Zool. Soc. London (1842) 6; Thesaurus Conchyl. 1 (1847) 10, pl. 2, figs. 92–95; 3 (1866) 295, pl. 12, figs. 437–439; Conchol. Icon. 19 (1874) *Helicina* pl. 28, figs. 246*a*–246*c;* Kobelt Landdeckelschnecken 4 (1886) 69, pl. 7, fig. 30; Cat. Phaneropneumona Brit. Mus. (1852) 288; Senckenberg. Naturf. Ges. (1893) 138.

GEOPHORUS AGGLUTINANS Sowerby. PANAY; BOHOL.
Helicina agglutinans SOWERBY, Proc. Zool. Soc. London (1842) 7; Thesaurus Conchyl. 1 (1847) 11, pl. 2, figs. 83–85; 3 (1866) 295, pl. 13, figs. 446, 447; Conchol. Icon. 19 (1874) *Helicina* pl. 25, figs. 220*a*, 220*b;* Kobelt Landdeckelschnecken 4 (1886) 69; Cat. Phaneropneumona Brit. Mus. (1852) 287; Abh. Naturf. Ges. 22 (1898) 179.

GEOPHORUS ? AURANTIO-VIRIDIS Sowerby. PHILIPPINES (?).
Helicina aurantio-viridis SOWERBY, Conchol. Icon. 19 (1874) *Helicina* pl. 11, fig. 97.

GEOPHORUS BOTHROPOMA Moellendorff. CAMARINES NORTE.

Nachrichbl. Malak. Ges. 27 (1895) 148.

GEOPHORUS CYRTOPOMA Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 180.

GEOPHORUS GIBBOSULA Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 180.

GEOPHORUS LAZARUS Sowerby. LUZON; BURIAS; LEYTE.

Helicina lazarus SOWERBY, Proc. Zool. Soc. London (1842) 7; Thesaurus Conchyl. 1 (1847) 11, pl. 2, fig. 91; 3 (1866) 295, pl. 13, figs. 444, 445; Conchol. Icon. 19 (1874) *Helicina* pl. 24, figs. 208*a*, 208*b*; Ann. & Mag. Nat. Hist. XIII 6 (1894) 59; Kobelt Landdeckelschnecken 4 (1886) 72; Cat. Phaneropneumona Brit. Mus. (1852) 289; Senckenberg. Naturf. Ges. (1890) 290; (1893) 139.

GEOPHORUS MONTICOLA Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 180.

GEOPHORUS NITIDULA Moellendorff. LUZON.

Abh. Naturf. Ges. 22 (1898) 180.

GEOPHORUS PSEUDOMPHALA Moellendorff. SIBUL, BULACAN.

Nachrichbl. Malak. Ges. 26 (1894) 119.

GEOPHORUS TROCHIFORMIS Sowerby. NEGROS; SAMAR.

Helicina trochiformis SOWERBY, Proc. Zool. Soc. London (1842) 7; Thesaurus Conchyl. 1 (1847) 10, pl. 2, fig. 10; 3 (1866) 295, pl. 12, fig. 440; Conchol. Icon. 19 (1874) *Helicina* pl. 7, fig. 52; Kobelt Landdeckelschnecken 4 (1886) 72; Cat. Phaneropneumona Brit. Mus. (1852) 289.

GEOPHORUS ? ZEBRIOLATA Pfeiffer. SAMAR.

Helicina zebriolata PFEIFFER, Thesaurus Conchyl. 3 (1866) 294, pl. 12, figs. 407, 408; Conchol. Icon. 19 (1874) *Helicina* pl. 26, fig. 229.

Genus CERATOPOMA Moellendorff

CERATOPOMA CAROLI Kobelt. SAMAR; LEYTE; SURIGAO.

Helicina caroli KOBELT, Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 70, pl. 7, figs. 26–27; Senckenberg. Naturf. Ges. (1893) 139.

CERATOPOMA CONTERMINA Semper. LUZON.

Helicina contermina SEMPER, Kobelt Landdeckelschnecken 4 (1886) 76, pl. 7, fig. 32; Ann. & Mag. Nat. Hist. XIII 6 (1894) 59, pl. 4, figs. 6, 6*a*; Abh. Naturf. Ges. 22 (1898) 180.

CERATOPOMA HENNIGIANA Moellendorff. LUZON.

Nachrichbl. Malak. Ges. 25 (1893) 184.

CERATOPOMA QUADRASI Moellendorff. TAYABAS.

Nachrichbl. Malak. Ges. 28 (1896) 15.

CERATOPOMA ROSALIAE Pfeiffer. LUZON.

Helicina rosaliae PFEIFFER, Thesaurus Conchyl. 3 (1866) 295, pl. 12, fig. 436; Conchol. Icon. 19 (1874) *Helicina* pl. 27, fig. 238; Kobelt Landdeckelschnecken 4 (1886) 71; Abh. Naturf. Ges. 22 (1898) 180.

Genus PLEUROPOMA Moellendorff

PLEUROPOMA CALAMIANICA Moellendorff. CALAMIANES.

Abh. Naturf. Ges. 22 (1898) 181.

PLEUROPOMA DICHROA Moellendorff. LEYTE; BOHOL; NEGROS.

Helicina dichroa MOELLENDORFF, Senckenberg. Naturf. Ges. (1890) 291; (1893) 140, pl. 5, figs. 12–12*b*; Abh. Naturf. Ges. 22 (1898) 181.

PLEUROPOMA SPHAERIDIUM Moellendorff. TABLAS.

Nachrichbl. Malak. Ges. 28 (1896) 15.

Genus SULFURINA Moellendorff

SULFURINA AMALIAE Kobelt. SURIGAO.

Helicina amaliae KOBELT, Reisen Philippinen, Kobelt Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 73, pl. 7, fig. 25.

SULFURINA CITRINA Grateloup. LUZON; CEBU; MINDANAO.

Helicina citrina GRATELOUP, Reisen Philippinen, Kobelt Landdeckelschnecken 4 (1886) 74, pl. 7, fig. 24; Cat. Phaneropneumona Brit. Mus. (1852) 274; *Helicina polita* SOWERBY, Proc. Zool. Soc. London (1842) 7; Thesaurus Conchyl. 1 (1847) 8, pl. 2, figs. 76–81; 3 (1866) 291, pl. 10, figs. 354–356; Conchol. Icon. 19 (1874) *Helicina* pl. 22, fig. 189.

SULFURINA CITRINELLA Moellendorff. LUZON; CEBU; MINDANAO.

Helicina citrinella MOELLENDORFF, Senckenberg. Naturf. Ges. (1893) 141; Abh. Naturf. Ges. 22 (1898) 182.

SULFURINA CROSSEI Semper. LUZON.

Helicina crossei SEMPER, Thesaurus Conchyl. 3 (1866) 291, pl. 10, figs. 337; Conchol. Icon. 19 (1874) *Helicina* pl. 18, fig. 158; Kobelt Landdeckelschnecken 4 (1886) 75, pl. 7, figs. 28, 29.

SULFURINA GLOBULINA Moellendorff. TABLAS; ROMBLON; SIBUYAN.

Abh. Naturf. Ges. 22 (1898) 182.

SULFURINA MARTENSI Issel. SULU.

Ann. & Mag. Nat. Hist. XIII 6 (1894) 59; Abh. Naturf. Ges. 22 (1898) 182.

SULFURINA MICHOLITZI Moellendorff. MINDORO.

Abh. Naturf. Ges. 22 (1898) 182.

SULFURINA PARVA Sowerby. LUZON; CEBU; SURIGAO.

Helicina parva SOWERBY, Kobelt Landdeckelschnecken 4 (1886) 75; Cat. Phaneropneumona Brit. Mus. (1852) 265; Proc. Zool. Soc. London (1842) 8; Thesaurus Conchyl. 1 (1847) 8, pl. 2, fig. 82; 3 (1866), 286, pl. 6, fig. 210; Conchol. Icon. 19 (1874) *Helicina* pl. 24, fig. 215.

Family HYDROCAENIDÆ Moellendorff

Genus GEORISSA Blanford

GEORISSA CARINULATA Quadras and Moellendorff. ISABELA.

Nachrichbl. Malak. Ges. 28 (1896) 15.

GEORISSA COCCINEA Quadras and Moellendorff. MASBATE.

Nachrichbl. Malak. Ges. 27 (1895) 88.

GEORISSA DENSELIRATA Moellendorff. MARINDUQUE.

Nachrichbl. Malak. Ges. 26 (1894) 120.

GEORISSA ELONGATULA Moellendorff. CALAMIAN GROUP.

Nachrichbl. Malak. Ges. 26 (1894) 120.

GEORISSA QUADRASI Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 144, pl. 5, figs. 13–13*b*.

GEORISSA REGULARIS Quadras and Moellendorff. BUSUANGA; TABLAS.

Nachrichbl. Malak. Ges. 27 (1895) 149.

GEORISSA RUFESCENS Moellendorff. LUZON; LUBANG.

Abh. Naturf. Ges. 22 (1898) 182.

GEORISSA STYLOPYCTA Moellendorff. CORON.

Nachrichbl. Malak. Ges. 26 (1894) 120.

GEORISSA SUBGLABRATA Moellendorff. LUZON; LEYTE; CEBU.

Senckenberg. Naturf. Ges. (1893) 145.

GEORISSA TURRITELLA Moellendorff. LEYTE.

Senckenberg. Naturf. Ges. (1893) 145, pl. 5, figs. 14–14*b*.

ADDENDA TO MONOGRAPH 25, "SUMMARY OF PHILIPPINE MARINE AND FRESH-WATER MOLLUSKS"

On page 67 add:

DOSINIA VARIEGATA Gray.

Thesaurus Conchyl. 1 (1847) 675, pl. 144, fig. 83; Conchol. Icon. 6 (1851) pl. 6, figs. 33*a–c*; Cat. Conchifera Brit. Mus. (1853) 24.

Surigao.

On page 71 add:

VENUS (CHIONE) PHILIPPII Deshayes.

Cat. Conchifera Brit. Mus. (1853) 146.

Philippines.

On page 74 add:

MERETRIX (DIONE) MULTIRADIATA Sowerby.

Cat. Conchifera Brit. Mus. (1853) 63.

Manila (?)

MERETRIX (DIONE) PHILIPPII Deshayes.

Cat. Conchifera Brit. Mus. (1853) 72.

Philippines.

On page 81 add:

PAPHIA RHOMBIFERA Deshayes.

Cat. Conchifera Brit. Mus. (1853) 161.

Philippines.

On page 189, under *Vivipara angularis* Mueller, add:

Proc. U. S. Nat. Mus. **32** (1907) 135, pl. 10, fig. 1.

On page 189 add:

VIVIPARA BULUANENSIS Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 140, pl. 11, fig. 15; **37** (1909) 365, pl. 34, fig. 2.
Lake Buluan, Mindanao.

On page 189, under *Vivipara carinata* Reeve, add:

Proc. U. S. Nat. Mus. **32** (1907) 141, pl. 11, fig. 14.

On page 189 add:

VIVIPARA CEBUENSIS Bartsch.

Proc. U. S. Nat. Mus. **37** (1909) 366, pl. 34, fig. 3; Proc. Biol. Soc. Wash. **31** (1918) 154.
Cebu.

VIVIPARA CLEMENSI Bartsch.

Proc. U. S. Nat. Mus. **37** (1909) 367, pl. 34, figs. 7, 8.
Lake Lanao, Mindanao.

On page 189, under *Vivipara cumingi* Hanley, add:

Proc. U. S. Nat. Mus. **32** (1907) 142, pl. 10, fig. 7.

On page 189 add:

VIVIPARA GILLIANA Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 145, pl. 10, fig. 12.
Lake Lanao, Mindanao.

VIVIPARA LANAONIS Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 145, pl. 11, fig. 7.
Lake Lanao, Mindanao.

VIVIPARA MAINITENSIS Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 148, pl. 10, figs. 9–11.
Lake Mainit, Surigao.

VIVIPARA MEARNSI Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 142, pl. 10, fig. 6.
Lake Lanao, Mindanao.

VIVIPARA MINDANENSIS Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 139, pl. 11, fig. 11; **37** (1909) 366, pl. 34, fig. 4.
Lake Lanao, Mindanao.

VIVIPARA PAGODULA Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 144, pl. 10, fig. 8.
Lake Lanao, Mindanao.

VIVIPARA PARTELLOI Bartsch.

Proc. U. S. Nat. Mus. **37** (1909) 366, pl. 34, figs. 5, 6.
Lake Lanao, Mindanao.

On page 190, under *Vivipara polyzonata* Frauenfeld, add:

Proc. U. S. Nat. Mus. **32** (1907) 147, pl. 11, fig. 13; **37** (1909) 365.

On page 190 add:

VIVIPARA ZAMBOANGENSIS Bartsch.

Proc. U. S. Nat. Mus. **32** (1907) 137, pl. 11, fig. 19.
Zamboanga.

Family HYDROBIIDÆ Fischer *

(Amnicolidæ Tryon)

Genus BITHINIA Gray

BITHINIA QUADRASI Moellendorff.

Nachrichbl. Malak. Ges. **28** (1896) 92.
Bohol.

Genus STENOTHYRA Benson

(*Nematura* Benson)

STENOTHYRA DECOLLATA Moellendorff.

Nachrichbl. Malak. Ges. **27** (1895) 77.
Mindanao.

Genus ASSIMINEA Leach

ASSIMINEA BREVICULA Pfeiffer.

Senckenberg. Naturf. Ges. (1890) 289; (1893) 105.
Leyte.

ASSIMINEA NITIDA Pease.

Senckenberg. Naturf. Ges. (1893) 106.
Limansaua.

ASSIMINEA QUADRASI Moellendorff.

Nachrichbl. Malak. Ges. **27** (1895) 77.
Masbate.

ASSIMINEA SEMILIRATA Boettger.

Senckenberg. Naturf. Ges. (1893) 106.
Marinduque.

Genus TRICULA Benson

TRICULA EXPANSILABRIS Quadras and Moellendorff.

Nachrichbl. Malak. Ges. **28** (1896) 92.
Bohol.

* Fresh or brackish water.

TRICULA HIDALGOI Quadras and Moellendorff.

Revista Real Academia Ciencias Madrid Sec. Ser. 22 (1925) 185, pl. 1, fig. 3.

Lake Mainit, Surigao.

Genus PETROGLYPHUS Moellendorff

PETROGLYPHUS MINDANAOICUS Moellendorff.

Nachrichbl. Malak. Ges. 26 (1894) 101.

Lake Mainit, Surigao.

On page 197, under the family Melaniidæ, add:

Genus PALUDOMUS Swainson

PALUDOMUS QUADRASI Moellendorff.

Nachrichbl. Malak. Ges. 26 (1894) 121.

Busuanga.

On page 198 add:

MELANIA CINCTA Lea.

Senckenberg. Naturf. Ges. (1893) 105.

Leyte.

On page 353 add:

AURICULA AURIS JUDAE Linnæus.

Cat. Auriculadæ, etc., Brit. Mus. (1857) 98.

Philippines.

AURICULA BRACHYSPIRA Moellendorff.

Auriculatra brachyspira Moellendorff. Abh. Naturf. Ges. 22 (1898) 135. See *Melampus brachyspirus* Moellendorff.

Philippines.

AURICULA ELONGATA Parreyss.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 107.

Burias.

AURICULA PONDEROSA Ferussac.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 100.

Philippines.

AURICULA QUADRASI Moellendorff.

Auriculastra quadrasi Moellendorff, Nachrichbl. Malak. Ges. 27 (1895) 118.

Masbate; Leyte; Cebu.

AURICULA SUBULA Quoy and Gaimard.

Senckenberg. Naturf. Ges. (1893) 103.

Leyte.

On page 354 add:

Genus PLECOTREMA H. and A. Adams

PLECOTREMA DOLIOLA Petit de la Saussaye.

Abh. Naturf. Ges. 22 (1898) 137. See *Auricula doliola* Petit de la Saussaye, *Cassidula doliola* Petit de la Saussaye.
Luzon.

PLECOTREMA EXARATA H. and A. Adams.

Abh. Naturf. Ges. 22 (1898) 137.
Mindanao.

PLECOTREMA HIRSUTA Garrett.

Senckenberg. Naturf. Ges. (1893) 103.
Limansaua.

PLECOTREMA LIRATA H. and A. Adams.

Abh. Naturf. Ges. 22 (1898) 136.
Catanduanes; Masbate; Mindanao.

PLECOTREMA MUCRONATA Moellendorff.

Nachrichbl. Malak. Ges. 26 (1894) 107.
Bohol.

PLECOTREMA OCTANFRATA Jonas.

Abh. Naturf. Ges. 22 (1898) 137.
Culion; Masbate; Leyte; Cebu; Mindanao.

PLECOTREMA PUNCTATOSTRIATA H. and A. Adams.

Senckenberg. Naturf. Ges. (1890) 261.
Cebu; Siquijor.

PLECOTREMA PUNCTIGERA H. and A. Adams.

Senckenberg. Naturf. Ges. (1890) 261.
Sibuyan; Cebu; Mindanao.

PLECOTREMA TYPICA H. and A. Adams.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 76.
Leyte.

Genus CASSIDULA Ferussac

CASSIDULA AURIS FELIS Bruguiére.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 90.
Manila.

CASSIDULA CRASSIUSCULA Mouss.

Abh. Naturf. Ges. 22 (1898) 138.
Luzon; Cebu; Mindanao.

CASSIDULA DOLIOLUM Petit de la Saussaye.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 83. See *Auricula doliola* Petit, *Plecotrema doliola* Petit.
Luzon.

CASSIDULA FABA Menke.

Abh. Naturf. Ges. 22 (1898) 138.
Cebu; Siquijor.

CASSIDULA KJAERULFIANA Beck.
Cat. Auriculidæ, etc., Brit. Mus. (1857) 93.
Philippines.

CASSIDULA LABIO Moellendorff.
Senckenberg. Naturf. Ges. (1893) 103.
Leyte.

CASSIDULA MUSTELINA Deshayes.
Abh. Naturf. Ges. 22 (1898) 139.
Luzon; Cebu; Busuanga.

CASSIDULA NUCLEUS Martyn.
Cat. Auriculidæ, etc., Brit. Mus. (1857) 88. See *Auricula nucleus* Gmelin.
Manila.

CASSIDULA SULCULOSA Mouss.
Cat. Auriculidæ, etc., Brit. Mus. (1857) 87.
Burias.

CASSIDULA TURGIDA Pfeiffer.
Cat. Auriculidæ, etc., Brit. Mus. (1857) 88.
Negros.

Genus BLAUNERIA Shuttlers

BLAUNERIA QUADRASI Moellendorff.
Nachrichbl. Malak. Ges. 27 (1895) 76.
Masbate.

Genus CYLINDROTIS Moellendorff

CYLINDROTIS QUADRASI Moellendorff.
Nachrichbl. Malak. Ges. 27 (1895) 77.
Masbate; Negros; Culion.

Genus LAIMODONTA Nuttall

LAIMODONTA CONICA Pease.
Abh. Naturf. Ges. 22 (1898) 136.
Calamianes; Palawan; Romblon; Masbate; Mindanao.

Genus MARINULA King

MARINULA CYMBAEFORMIS Recluz.
Abh. Naturf. Ges. 22 (1898) 136; Cat. Auriculidæ, etc., Brit. Mus. (1857) 47.
Ticao.

Genus PEDIPES Adanson

PEDIPES JOUANI Montrouzier.
Senckenberg. Naturf. Ges. (1893) 104.
Limansaua.

On page 355 add:

MELAMPUS BOHOLENSIS H. and A. Adams.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 27.

Bohol; Limansaua.

MELAMPUS BRACHYSPIRUS Moellendorff.

Nachrichbl. Malak. Ges. 26 (1894) 106. See *Auricula brachyspira* Moellendorff.

Cebu.

MELAMPUS BREVIS ? Gassies.

Abh. Naturf. Ges. 22 (1898) 141.

Luzon; Cebu; Cuyo.

MELAMPUS CAFFER Küster.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 29.

Bohol; Capul.

MELAMPUS COSTATUS Quoy and Gaimard.

Abh. Naturf. Ges. 22 (1898) 142. See *Auricula costata* Quoy and Gaimard.

Philippines.

MELAMPUS FASCIATUS Deshayes.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 28.

Leyte.

MELAMPUS GRANIFER Mouss.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 30.

Burias.

MELAMPUS LUTEUS Quoy and Gaimard.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 26.

Leyte.

MELAMPUS NUCLEOLUS Mart.

Abh. Naturf. Ges. 22 (1898) 140.

Luzon; Cebu; Mindanao.

MELAMPUS PHILIPPII Küster.

Abh. Naturf. Ges. 22 (1898) 140.

Calamianes; Bohol.

MELAMPUS PULCHELLUS Petit de la Saussaye.

Cat. Auriculidæ, etc., Brit. Mus. (1857) 25. See *Auricula pulchella* Petit de la Saussaye.

Cebu.

MELAMPUS SEMIPLICATUS Pease.

Abh. Naturf. Ges. 22 (1898) 141.

Luzon; Cebu; Mindanao.

MELAMPUS SINGAPORENSIS Pfeiffer.

Abh. Naturf. Ges. 22 (1898) 140.

Manila.

MELAMPUS STRIATUS Pease.

Abh. Naturf. Ges. 22 (1898) 141.

Luzon; Negros; Mindanao.

MELAMPUS TRITICEUS Philippi.

Abh. Naturf. Ges. 22 (1898) 141.

Cuyo; Negros.

MELAMPUS (TRALIA) LANLEYANA Gass.

Senckenberg. Naturf. Ges. (1893) 102.

Leyte.

SCARABUS OVATUS Pfeiffer.

Pythia ovata Pfeiffer, Abh. Naturf. Ges. 22 (1898) 133.

Masbate.

SCARABUS REEVEANUS Pfeiffer.

Pythia reeveana Pfeiffer, Cat. Auriculidæ, etc., Brit. Mus. (1857) 61; Senckenberg. Naturf. Ges. (1893) 102. See *Scarabus imbrium* Montfort.

Leyte.

On page 355, under the family Lymnaeidæ, add:

Genus LYMNAEA Lamarck

LYMNAEA PHILIPPINENSIS Nevill.

Senckenberg. Naturf. Ges. (1893) 104.

Philippines.

PLANORBIS QUADRASI Moellendorff.

Senckenberg. Naturf. Ges. (1893) 105, pl. 3, figs. 11–11*c*.

Montalban, Rizal.

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VOL. 42 JUNE, 1930 NO. 2

NOTE ON THE VIABILITY OF TREPONEMA LUIS

By ISAO MIYAO[1]

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The experiments concerning the viability of treponema luis found in the literature are fairly numerous. Many of them were conducted with the view to determine the infectiousness of various articles polluted with secretions from syphilitic lesions. In the course of investigations concerning various phases of the problem of human treponematoses conducted in our institute, it became necessary to perform the present experiments. These were conducted with treponema luis under the same conditions as those with treponema framboesiæ performed previously by Yasuyama; therefore, a comparative evaluation of these experiments is permissible.

The experimental data concerning the viability of treponema luis were gathered from the literature and critically considered by E. B. Vedder.[2]

The experiments of Lacy and Haythorn[3] are comparable with ours, on account of similarity of purpose and experimental procedure. These authors sought information with regard to the viability of treponema luis in material obtained from autopsy and biopsy. The purpose was to ascertain the possibility of diagnosis of syphilitic infection by microscopic examination or

[1] Lieutenant Surgeon, Imperial Japanese Navy.

[2] Syphilis and Public Health. Lea and Febiger, Philadelphia and New York (1918) 121.

[3] Am. Journ. Syphilis 5 (1921) 401.

inoculation to experimental animals and the possibility of contracting the disease by handling syphilitic material obtained by autopsy or biopsy. By means of inoculation experiments they found that these materials remain infectious for from twenty-four to twenty-six hours.

EXPERIMENTAL PROCEDURE

The syphilitic material used in these experiments was obtained from the testicles of rabbits inoculated with the Nichols strain of syphilis. Immediately after the castration the testicular tissue was cut into small pieces, thoroughly ground up in a sterile mortar, and suspended in salt solution. At intervals of time, indicated in the tables, normal rabbits were inoculated by intratesticular injection. The inoculated rabbits were kept under observation and examined at frequent intervals by inspection and by the dark-field microscope for the presence of treponemas. Rabbits that died prematurely without showing any indication of syphilitic lesion were excluded.

Three trials were made. In each trial the material obtained from a rabbit inoculated with the Nichols strain of syphilis was injected immediately into the testicles of a normal rabbit to assure that the material contained viable treponemas of syphilis. The emulsion of the syphilitic testicular tissue was then allowed to stand at room temperature, 28.5° C., and at intervals of time indicated in the tables 0.5 cubic centimeter of this emulsion was injected into testicles of normal rabbits.

The results of these three experiments are given in Tables 1 and 2. In agreement with those of Lacy and Haythorn the results show that the treponema of syphilis may retain its virulence in tissue suspension for twenty-four hours. At 37° C. and at 0° C. it remains infectious for at least four hours.

The experiments of Yasuyama [4] performed under the same conditions showed that the treponema of yaws survived at room temperature or at 37° C. two hours and died at 0° C. in less than fifteen minutes.

CONCLUSION

The treponema of syphilis is far more resistent to adverse conditions prevailing outside of body than the treponema of yaws.

[4] Philip. Journ. Sci. **35** (1928) 333.

ACKNOWLEDGMENT

Thanks are due to Dr. Otto Schöbl, chief of division of biology and serum laboratory, Bureau of Science, for courtesies received in carrying out these experiments.

TABLE 1.—*Showing the results of the tests for viability of Treponema pallidum outside of the body organism at room temperature (average, 28.5° C.).*

[+, positive take; —, negative take.]

Designation of rabbit.	Length of exposure.	Date of inoculation.	Result, clinical and microscopical.	Date of appearance of lesion.
Sy-16-A	Immediate	X-1-28	+	X-24-28
Sy-16-B	Thirty minutes	X-1-28	+	X-24-28
Sy-17	One hour	X-1-28	+	X-24-28
Sy-40	do	XII-11-28	+	I-8-29
Sy-18	Two hours	X-1-28	+	X-24-29
Sy-41	do	XII-11-28	+	I-28-29
Sy-24	Three hours	XII-11-28	+	II-5-29
Sy-49	Immediate	II-5-29	+	III-14-29
Sy-50	Three hours	II-5-29	+	III-14-29
Sy-51	Four hours	II-5-29	+	IV-10-29
Sy-19-A	Immediate	IV-11-29	+	VI-1-29
Sy-19-B	Four hours	IV-11-29	+	V-13-29
Sy-20-A	Five hours	IV-11-29	+	VI-1-29
Sy-20-B	Six hours	IV-11-29	+	VI-1-29
Sy-21-A	Seven hours	IV-11-29	+	V-14-29
Sy-21-B	Twelve hours	IV-11-29	+	V-23-29
Sy-22	Twenty-four hours	IV-11-29	+	V-23-29
Sy-61-B	do	V-18-29	+	VIII-6-29

TABLE 2.—*Showing the results of the tests for viability of Treponema pallidum outside of the body organism at various temperatures.*

[+, positive take; —, negative take.]

Designation of rabbit.	Length of exposure.	Temperature to which exposed.	Date of inoculation.	Result, clinical and microscopical.	Date of appearance of lesion.
		°C.			
Sy-62	Immediate		V-29-29	+	VII-7-29
Sy-60	Four hours	37	V-18-29	+	VI-28-29
Sy-61-A	do	0	V-18-29	+	VI-28-29

SEROLOGIC RECIPROCITY BETWEEN YAWS AND SYPHILIS [1]

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EIGHT CHARTS

The in vitro antigen which is used in performing the serum reactions in human treponematoses is not derived from any constituent of the parasites themselves. Consequently the serologic relationship between these two infections cannot be studied by the same methods that are used in cross-serologic studies of other infectious agents.

Our previous experiments, however, demonstrated [2] that superinfection with yaws of yaws-infected or yaws-vaccinated monkeys produces a definite change in their serologic picture. The plan was, therefore, conceived to study the serologic relationship between yaws and syphilis experimentally, in such a way that the effect of inoculation with one of the diseases, on the serologic picture already produced in the same animals by the other disease, may become apparent.

All of the possible combinations of cross-inoculation have not been exhausted by our experiments, but the fundamental principles came to light.

EXPERIMENTAL PROCEDURE

Simultaneous Wassermann and Kahn tests were performed on the animals. As far as the technic of these reactions is concerned the reader is referred to our previous publications dealing with the same subject.[3] Four degrees of the strength of the serologic reactions were considered, and the time was registered in weeks, counting from the time of inoculation or vaccination. The blood was examined in most cases at two and three week intervals. The results were plotted in curves. Two

[1] Received for publication, November 15, 1929.

[2] Philip. Journ. Sci. **35** (1928) 272; **40** (1929) 57–89.

[3] Loc. cit.

kinds of animals were used: monkeys, highly tissue-reactive to yaws, and rabbits, highly reactive to the strain of syphilis used in these experiments (Nichols).

The combinations of cross-inoculation between yaws and syphilis presented in this communication were:

1. Monkeys (intradermal inoculation).
   (*a*) Yaws infection-yaws superinfection.
   (*b*) Yaws infection-syphilis infection.
   (*c*) Syphilis infection-syphilis superinfection.
   (*d*) Syphilis infection-yaws infection-syphilis superinfection.
   (*e*) Syphilis vaccination (subcutaneous)-yaws infection (intradermal).
2. Rabbits (intratesticular inoculation).
   (*a*) Syphilis infection-syphilis superinfection.
   (*b*) Syphilis vaccination (subcutaneous)-syphilis infection.
   (*c*) Yaws vaccination (subcutaneous)-syphilis infection.

EXPERIMENT I (MONKEYS)

YAWS INFECTION (INTRADERMAL)-YAWS SUPERINFECTION (INTRADERMAL)

This chart (fig. 1) was plotted from the results of previous experiments concerning the serologic effect of superinoculation with yaws performed on yaws-infected monkeys. It is included in this communication to serve as a basis for the interpretation of the results obtained in the present experiments. Wassermann reaction only was performed. The curves show the cumulative effect of superinfection. The law of inverse proportions between the serologic effect of the first infection with yaws and the second inoculation with the same treponema is clearly evident.

EXPERIMENT II (MONKEYS)

YAWS INFECTION (INTRADERMAL)-SYPHILIS INFECTION (INTRADERMAL)

Seven monkeys were inoculated with Guzon strain of yaws. This is a different strain from the Cadangan strain of yaws. It was isolated from a patient in the Philippines. One of the monkeys gave positive serologic reaction coincident with the yaws lesion. Five of the seven animals were superinoculated with syphilis eleven, sixteen, and twenty-four weeks, respectively, after the inoculation with yaws. There was a distinct rise in the Kahn reaction in all of the three superinoculated animals within the first two weeks after the superinoculation with syphilis of the yaws monkeys, and a distinct rise in the

Wassermann curve in from four to eleven weeks after the superinoculation with syphilis.

This experiment shows that superinoculation with syphilis of yaws-infected monkeys has the same serologic effect as superinoculation with yaws of yaws-infected animals (see Experiment I). It further shows that in these instances a single inoculation, with either yaws or syphilis performed on normal monkeys, may not have any apparent effect on the early serologic picture and yet produce a change in the serologic reactivity of singly inoculated animals which becomes apparent on superinoculation.

The two controls (that is, monkeys inoculated with yaws only once) showed a rise in serologic reactions twenty-seven and twenty-eight weeks, respectively, after the inoculation with yaws. This is the late serologic response to a single inoculation. Yaws animals which were superinoculated with syphilis sixteen and twenty-four weeks, respectively, after the original inoculation with yaws showed accelerated late serologic reactions.

The time when the late serologic response to a single inoculation becomes evident (that is, twenty-six to twenty-eight weeks) corresponds remarkably to the time when resistence to inoculation with yaws is completed.

EXPERIMENT III (MONKEYS)

SYPHILIS INFECTION (INTRADERMAL)-SYPHILIS SUPERINFECTION (INTRADERMAL)

Six Philippine monkeys were inoculated intradermally with the Nichols strain of syphilis. Only one of the animals showed a slight rise of Wassermann reaction in consequence of the first inoculation, coincident with the syphilitic skin lesion. The Kahn test remained negative. Three of the six monkeys died; one ten, another fifteen, and the third eighteen weeks after the inoculation. Of the remaining three, two were superinoculated with syphilis.

No lesion developed as a consequence of the superinoculation and no serologic effect was noticed. In one singly inoculated control, a slight rise in the serologic curves was noticeable, twenty-seven weeks after the original inoculation.

This experiment shows that Philippine monkeys are not as reactive to syphilis as they are to yaws.

EXPERIMENT IV (MONKEYS)

SYPHILIS INFECTION (INTRADERMAL)-YAWS INFECTION (INTRADERMAL)-SYPHILIS SUPERINFECTION (INTRADERMAL)

Five monkeys were inoculated intradermally with the Nichols strain of syphilis. All responded to the inoculation by positive serum reactions coincident with the skin lesion. The serologic response was weak. In one animal the Wassermann reaction was positive, but the Kahn test remained negative; in another the reverse findings were made. In the rest of the monkeys, both reactions applied in the experiment resulted positive. The animals were superinoculated with yaws twelve, thirteen, and sixteen weeks, respectively, after the inoculation with syphilis. The serologic response to the superinoculation with yaws of syphilitic monkeys was greater in every case, either by one or the other of the two tests performed, than the response following the first inoculation, that is with syphilis. When four of these animals were retested, from thirty to thirty-four weeks after the original inoculation with syphilis, they gave strong serologic reactions. At this time they were superinfected again with syphilis. An immediate drop of the curves followed, after which the curves repeatedly rose and dropped. While the Wassermann reaction oscillated between strong and minus reaction, the Kahn test followed the same course but on the whole remained strongly positive. This is due to the reading of the results. While the Kahn test was registered as an average of several test tubes, the Wassermann test was registered as a result in that test tube which showed the strongest inhibition with cholesterinized antigen.

In this experiment both inoculations produced serologic response. The law of inverse proportions is plainly discernible in the results of cross superinoculation with syphilis and yaws. The curves compiled from the results of this experiment show the same general course as the curves plotted from the results of superinfection with homologous treponemas. The serologic reciprocity between the two treponemas under experimentation is evident. Besides the law of inverse proportions another phenomenon came again to light; that is, the existence of an early serologic response coincident with the initial lesion and a late response which became noticeable long after the primary lesion healed. These two serologic phenomena are separated by a period of negative serologic findings.

EXPERIMENT V (MONKEYS)

SYPHILIS VACCINE (SUBCUTANEOUS)-YAWS INFECTION (INTRADERMAL)

Six monkeys were used in this experiment. Three of the animals received four injections of syphilis vaccine, and three animals received two vaccinations.

Three of these monkeys were tested during eight weeks and three during twelve weeks after the first vaccination. No serologic change was found. At the end of this time all of the monkeys were inoculated with yaws. Two of them showed no yaws lesion and no serologic change (failure take). One developed a yaws lesion, but no serologic effect was noticed up to the death of the animal fourteen weeks after the inoculation with yaws. The three remaining monkeys reacted serologically to the inoculation with yaws. One reacted slightly by Wassermann and Kahn tests, this reaction being coincident with the specific yaws lesion; another one reacted distinctly, first by Wassermann and then by Kahn tests coincident with the duration of the lesion; the third monkey reacted very strongly. There was a rise in the curve just before healing took place, then a drop following healing. Both curves rose again and remained at the highest point for several months. The animal that failed to react to vaccination with syphilis, failed to take the following inoculation with yaws, was inoculated with syphilis thirty-seven weeks after the first vaccination. It failed to show clinical lesion at the place of inoculation with syphilis, but seven weeks after the inoculation the animal gave strong positive serologic reaction by both tests used.

This experiment is further illustration of the phenomena pointed out in the descriptions of the results of previous experiments.

EXPERIMENT VI (RABBITS)

SYPHILIS INFECTION-SYPHILIS SUPERINFECTION (INTRATESTICULAR)

Four rabbits were inoculated with syphilis by intratesticular injection. All responded to the inoculation by strong Kahn reaction; two weakly and two strongly by Wassermann test. The strongest serologic response was noticed in rabbit Sy–52. This animal received two inoculations in rapid succession, within the first five weeks after the first inoculation. One animal was superinfected with syphilis fourteen weeks after the first inoculation and responded quickly to the superinfection by strong ser-

ologic reactions. In the last two animals (Sy–52 and Sy–53) there appeared a recrudescence of positive Wassermann test twenty-six and twenty-seven weeks, respectively, after the original inoculation. The Kahn test remained strongly positive throughout.

This experiment shows that rabbits react serologically to syphilis more strongly than monkeys. The direct proportion between the severity of infection and the degree of serologic response is apparent (rabbit Sy–52), and the phenomenon of early serologic response and a late one again comes to view. It is further evident that rabbits respond to syphilitic infection far more strongly by positive Kahn reaction than they do by Wassermann reaction. With regard to the Kahn test, the early response and the late one overlap in such a manner that a continuous high Kahn curve resulted, showing only a slight drop after healing of the lesion.

EXPERIMENT VII (RABBITS)

SYPHILIS VACCINE (SUBCUTANEOUS)-SYPHILIS INFECTION (INTRATESTICULAR)

Six rabbits were injected repeatedly with killed syphilis vaccine (subcutaneous). All responded serologically to the vaccination—one very weakly (only the Kahn test gave a slightly positive result), two distinctly by both reactions, and three gave strongly positive results by both tests employed. The serologic picture of these animals returned to normal rather quickly. An indefinite late rise of the Kahn curve was noticed in one of the animals, while the Wassermann curve remained at zero. Another animal showed a distinct rise in the Kahn curve which commenced twenty-two weeks and reached its highest point (+ +) thirty-two weeks after the vaccination. The Wassermann curve remained throughout this time at zero. Three of these animals were inoculated with syphilis. Two of them developed lesions and both serologic curves rose high, coincident with the lesion. While the Wassermann curves returned to zero following healing of the lesions, the Kahn curves remained high. The third rabbit inoculated with syphilis developed no clinical lesion and showed indefinite repeated rise of the Kahn but no change in the Wassermann curve.

This experiment shows that rabbits are more highly reactive to syphilis than monkeys. The same vaccine failed to produce manifest serologic response in monkeys, but in rabbits it pro-

voked distinctly positive serologic results. The peculiarity of syphilitic rabbits with regard to the Kahn test is also evident.

EXPERIMENT VIII (RABBITS)

YAWS VACCINE (SUBCUTANEOUS)-SYPHILIS INFECTION (INTRATESTICULAR)

Five rabbits were vaccinated by subcutaneous injection of heated yaws vaccine. In all but possibly one a slight response on the part of the Kahn test was noticed. The Wassermann test, however, remained negative in all of them. Following intratesticular inoculation with syphilis two animals died two and a half weeks after the infection with syphilis and nineteen weeks after the vaccination with yaws vaccine. The remaining three rabbits responded serologically to the infection with syphilis. One responded by a rapid rise of the Kahn curve; this animal unfortunately died six weeks after the inoculation with syphilis, consequently the curves remained unfinished. The other two lived long enough to show the entire serologic curve.

Coincident with the clinical lesion both Wassermann and Kahn curves rose. While the Kahn curve remained high with slight drops, the Wassermann curve dropped to zero following the healing of the lesion.

Thirty-six and thirty-nine weeks after the vaccination and twenty-six and twenty-nine weeks, respectively, after the inoculation with syphilis, the Wassermann curve rose steeply and dropped again to zero. The Kahn curve showed an analogous drop, but of lesser degree, and remained high.

This experiment furnishes additional evidence that rabbits respond serologically less to yaws than they do to syphilis.

SUMMARY OF FINDINGS

The fundamental principles underlying the serologic reactions in treponematoses can be deduced from the findings made in these experiments. Throughout the record curves of our experiments it is evident that the serologic effect of superinoculation is based on the principle of sensitization. While a single infection with syphilis or injection of syphilis vaccine, for instance, produced no change in the serologic picture of monkeys, it sensitized those animals to such an extent that superinoculation with yaws resulted in a strong serologic response.

There is ample evidence in the results of our experiments that there exists a complete serologic reciprocity between yaws and

syphilis. It is immaterial whether the first inoculation or the vaccination, that is to say the sensitization, is produced by yaws or syphilis, the effect of superinoculation with either of the two treponemas may be the same and will follow the laws that govern the effect of superinoculation with homologous treponemas.

The effect of superinoculation and the laws governing it are evidently interfered with by the factor of relative susceptibility of the particular experimental animal to one or the other of the treponematoses. The treponema of yaws shows higher aggressivity towards monkey than towards rabbit. In our experiments with the Nichols strain of syphilis we found the opposite to be true. The serologic reactivity in treponematoses of experimental animals depends on the tissue reactivity of the skin. This was experimentally demonstrated[4] and is evident in our serologic charts from the coincidence of the strongest early serum reactions with the development and duration of the skin lesion. The initial syphilitic skin lesion in the Philippine monkey is small, relatively short lived, and contains very few treponemas. The serologic response, therefore, is slight. The sensitizing effect, however, is sufficient. In rabbits, the initial syphilitic skin lesion (the chancre) is extensive, of long duration, and contains numerous treponemas. The serologic response, therefore, to syphilitic infection in rabbits is far stronger than in monkeys. It appears to be a peculiarity of rabbits that the Kahn test is much stronger with these animals than the Wassermann test. However, the parallel curves compiled from the results of the two tests show the same course, but are not necessarily synchronic. The oscillations in the Wassermann curve show larger elongations than those in the Kahn curve. The early serologic response, if it becomes manifest, is coincident with the primary lesion. It may not be apparent in sensitized animals. If it is, it returns to zero. This drop is followed by a strong rise in the serologic curves, six to seven months after the inoculation. This second rise is usually absent in vaccinated animals that have not been inoculated.

The early and the late rise in serologic curves may overlap; particularly if the early response is strong and the inoculation and the superinoculation are performed in rapid succession.

These phenomena have more significance than a mere serologic interest. The late serologic response to a single inoculation

[4] Miyao, I., Philip. Journ. Sci. 40 (1929) 71–74.

appears about the time when resistance has reached such a degree that a lesion does not develop upon superinoculation performed at this time. If superinoculation is timed so that it is performed shortly after the early serologic response has returned to zero, the late serologic rise is not only increased but accelerated as well. It is a sign that immunity, too, may result stronger and quicker.

CONCLUSIONS

1. The behavior of serologic reactions as a consequence of superinoculation in treponematoses points to sensitization as the underlying principle. An early serologic response and a late one are frequently detectable in animals singly inoculated with treponemas. The early response is coincident with the primary treponematous lesion and is an indication of strong sensitization of the animal's tissues; the late one is coincident with the full development of immunity and indicates the time when a lesion will no longer develop upon superinoculation.

2. Superinoculation, performed on infected or vaccinated animals, increases and accelerates the late serologic response. This indicates that similar conditions may exist with regard to immunity to treponematoses.

3. Serologic reciprocity between yaws and syphilis exists. The serologic effect of cross-superinfection follows the same laws that govern the serologic effect of superinfection with homologous treponemas.

4. The serologic reactivity of a given experimental animal is directly proportionate to the tissue reactivity of that animal towards the particular kind of treponemas; in other words, it stands in direct proportion to the number of invading parasites.

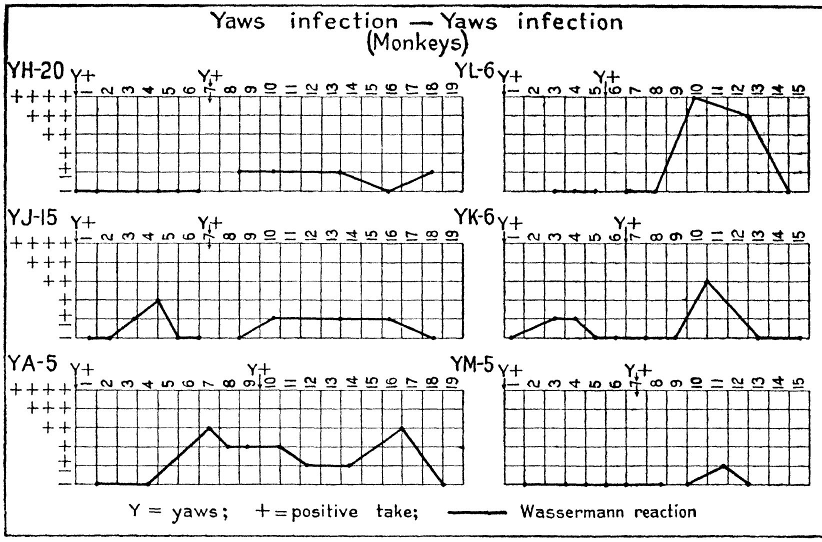

FIG. 1. Yaws infection-yaws infection (monkeys). Each square represents one week.

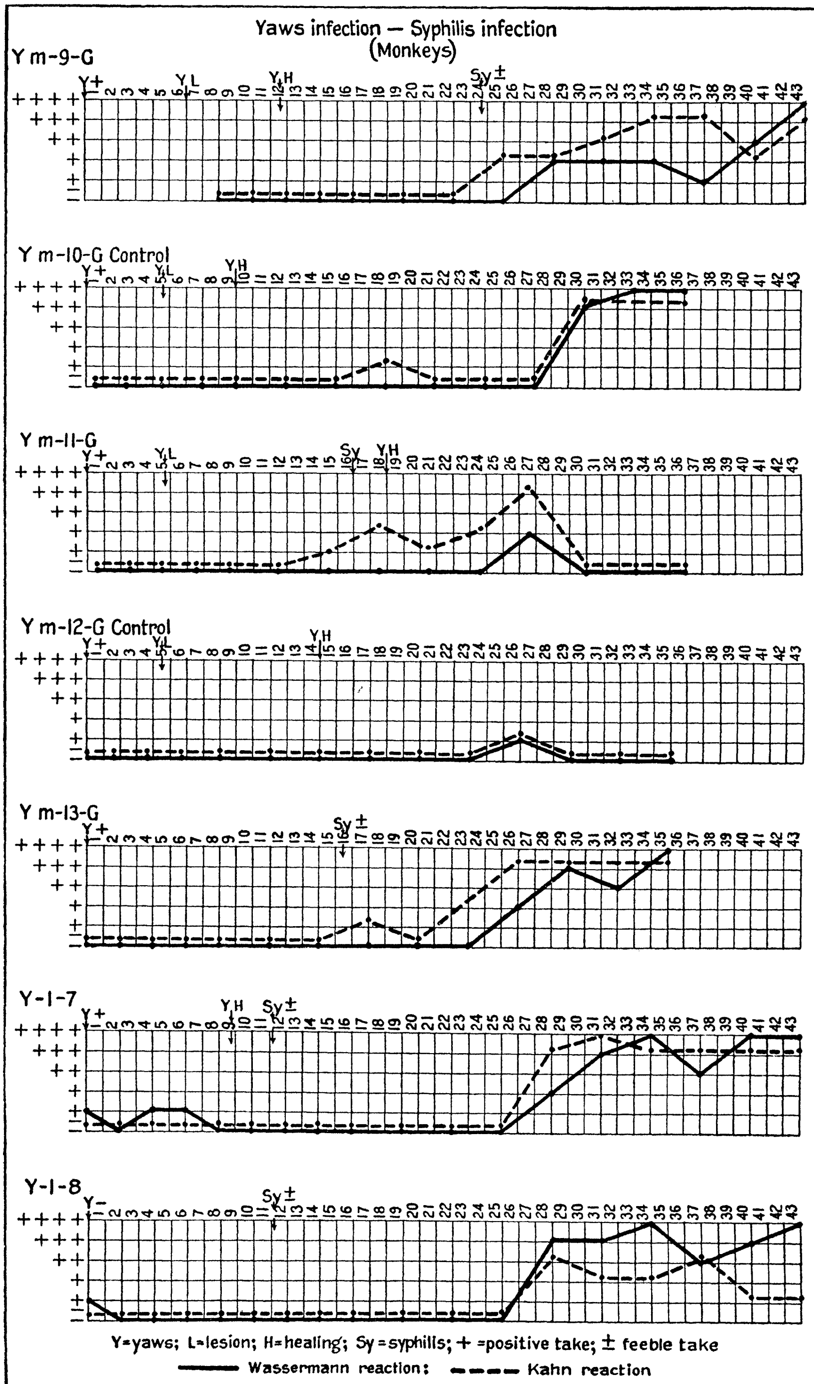

FIG. 2. Yaws infection-syphilis infection (monkeys). Each square represents one week.

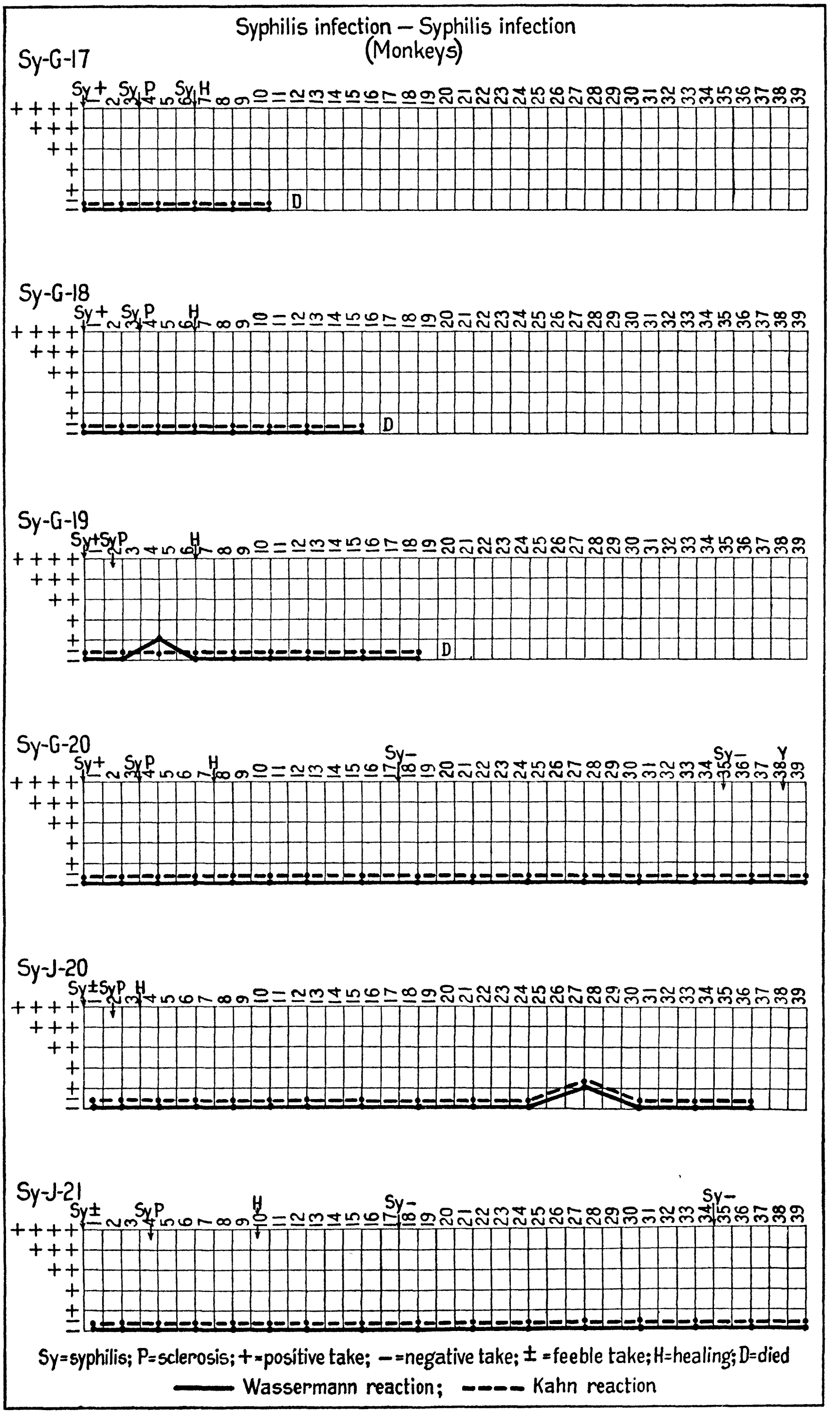

FIG. 3. Syphilis infection-syphilis infection (monkeys). Each square represents one week.

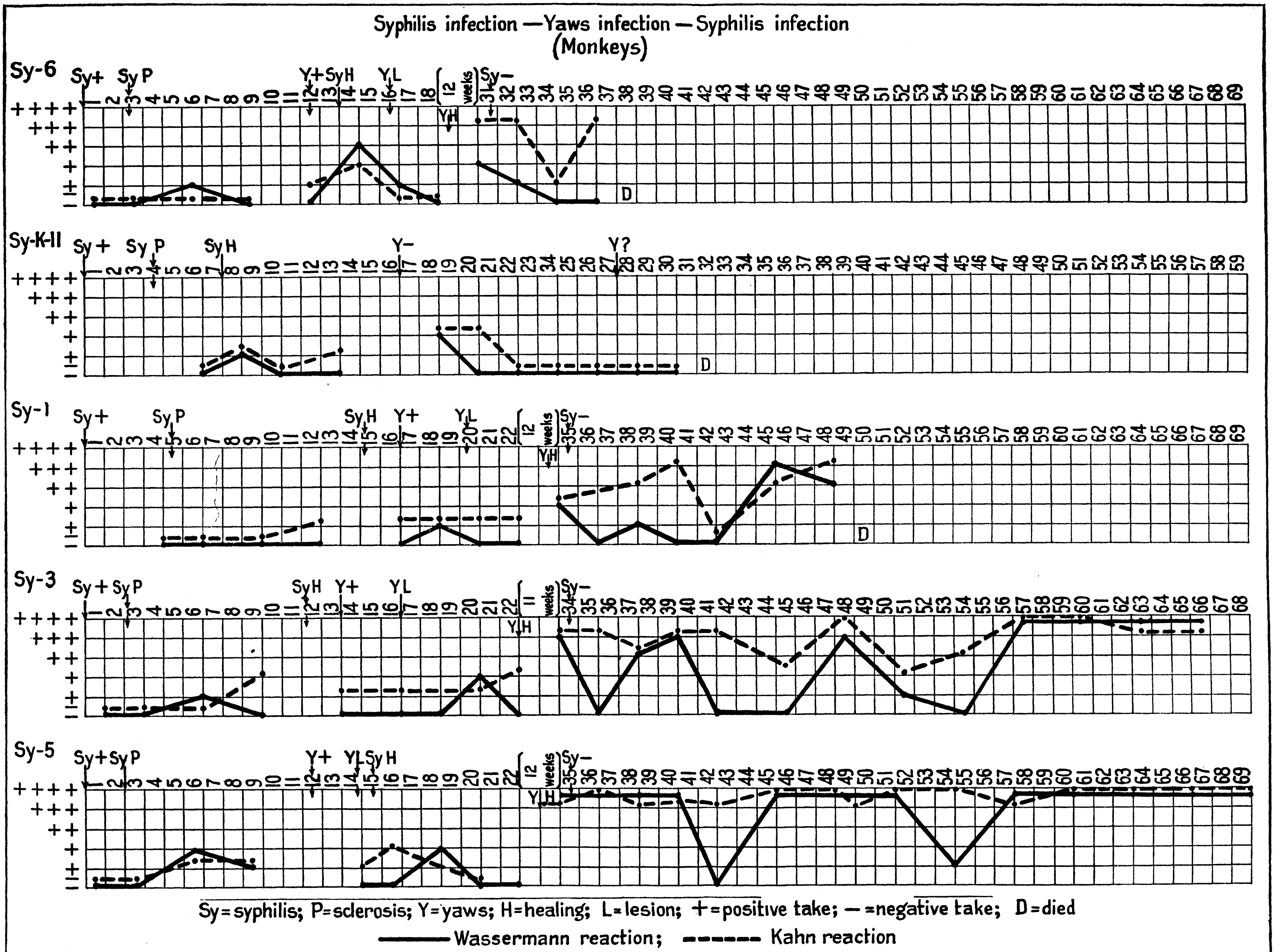

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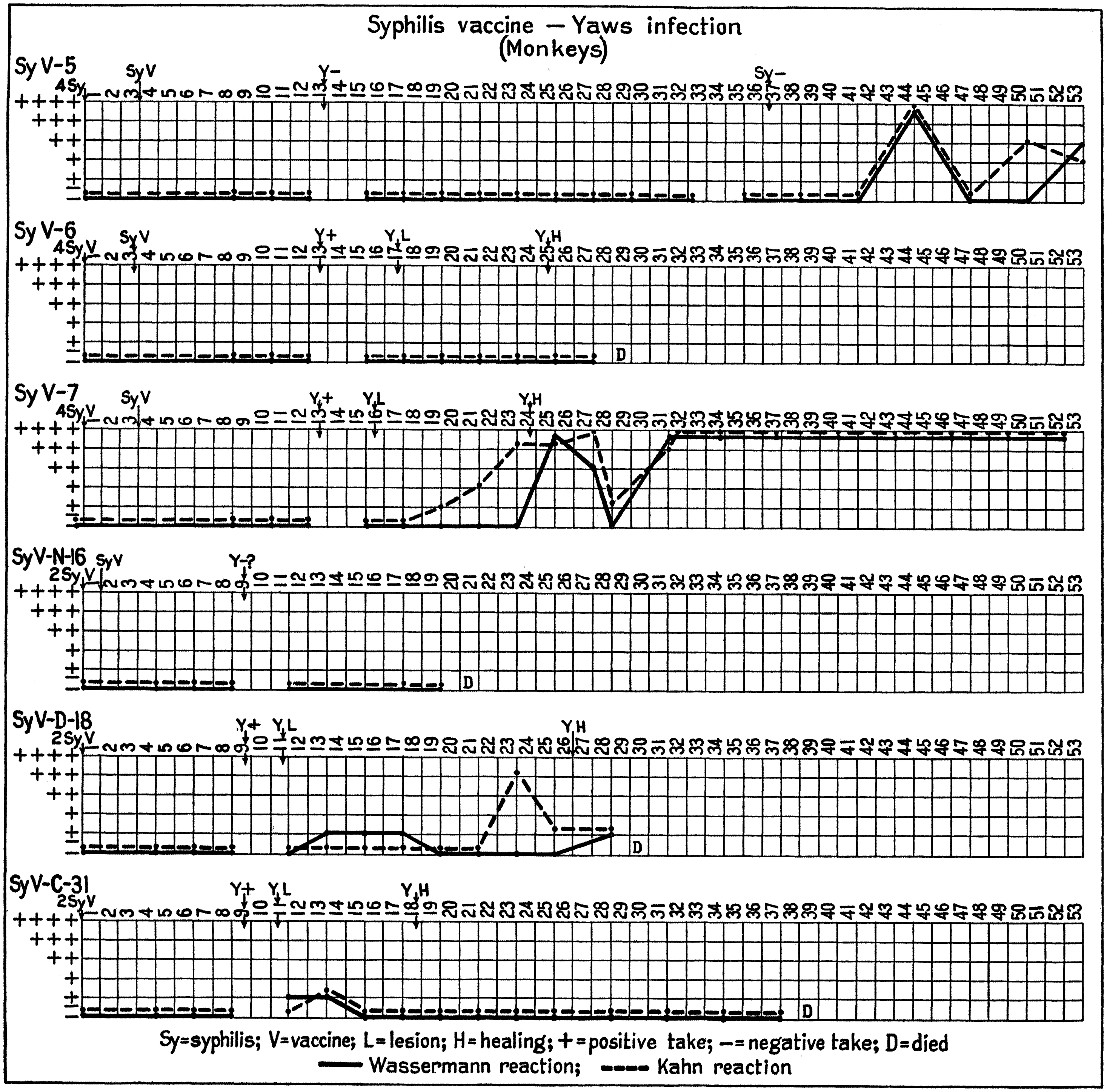
FIG. 4. Syphilis infection = yaws infection = syphilis infection (monkeys). Each square represents one week.



250982. Facing page 214. FIG. 5. Syphilis vaccine = yaws infection (monkeys). Each square represents one week.

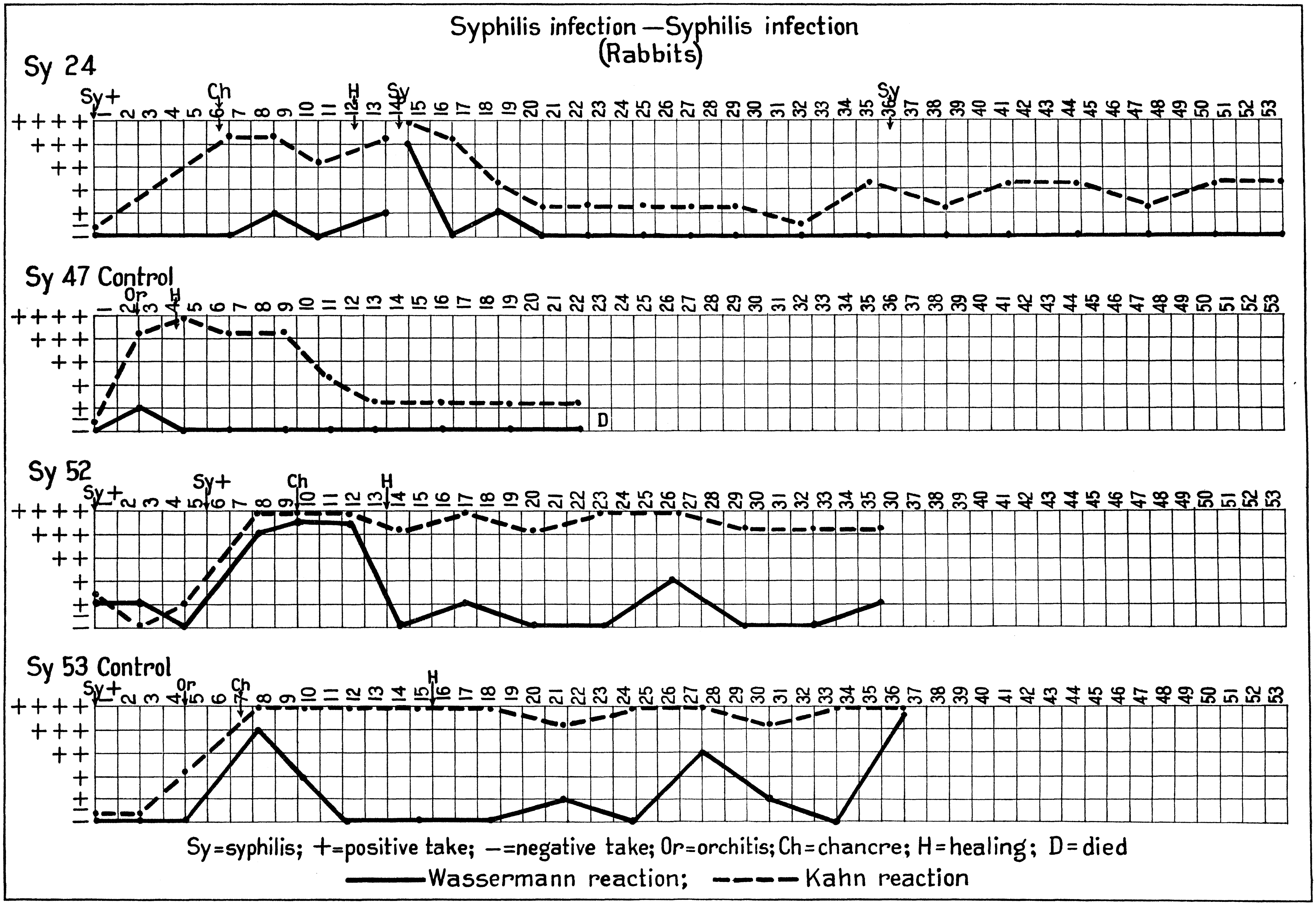


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FIG. 6. Syphilis infection = syphilis infection (rabbits). Each square represents one week.

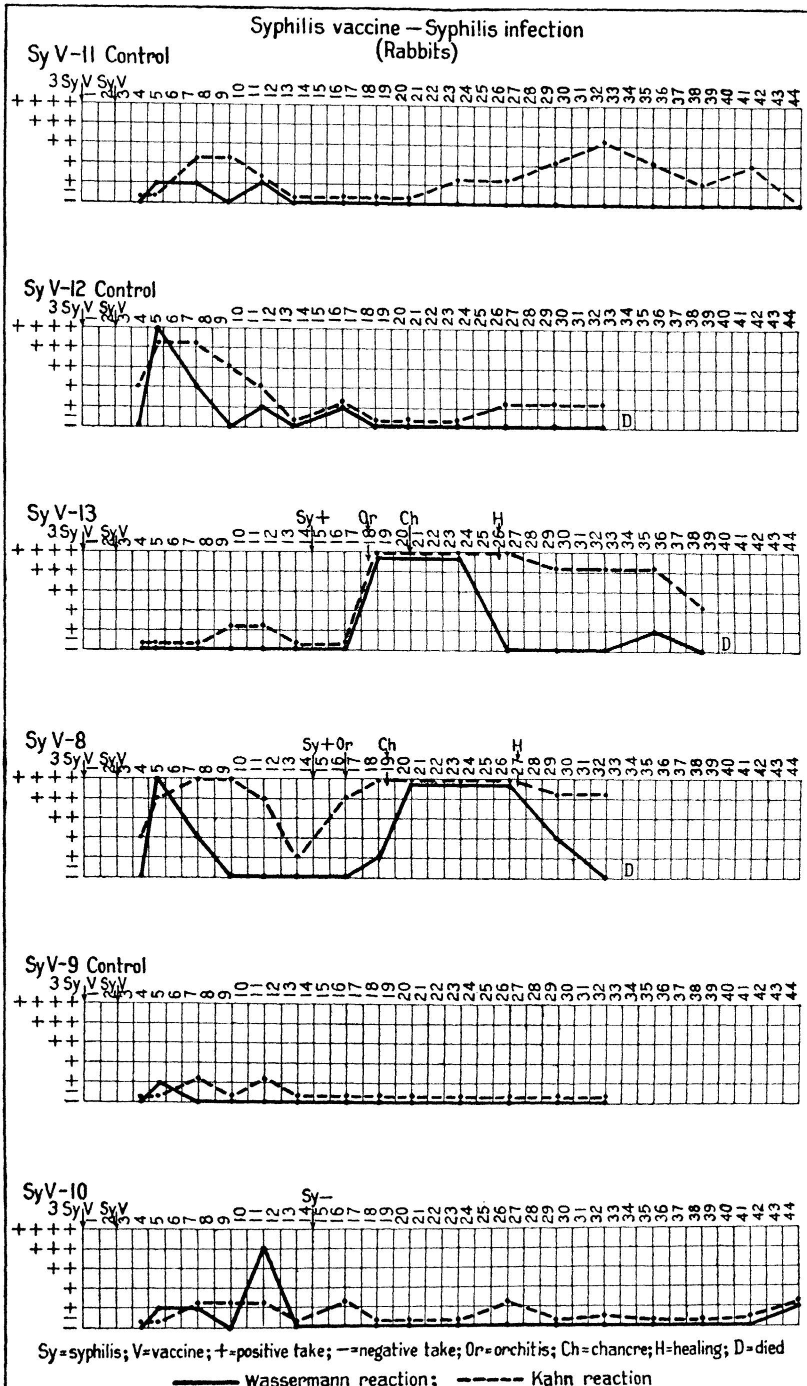

FIG. 7. Syphilis vaccine-syphilis infection (rabbits). Each square represents one week.

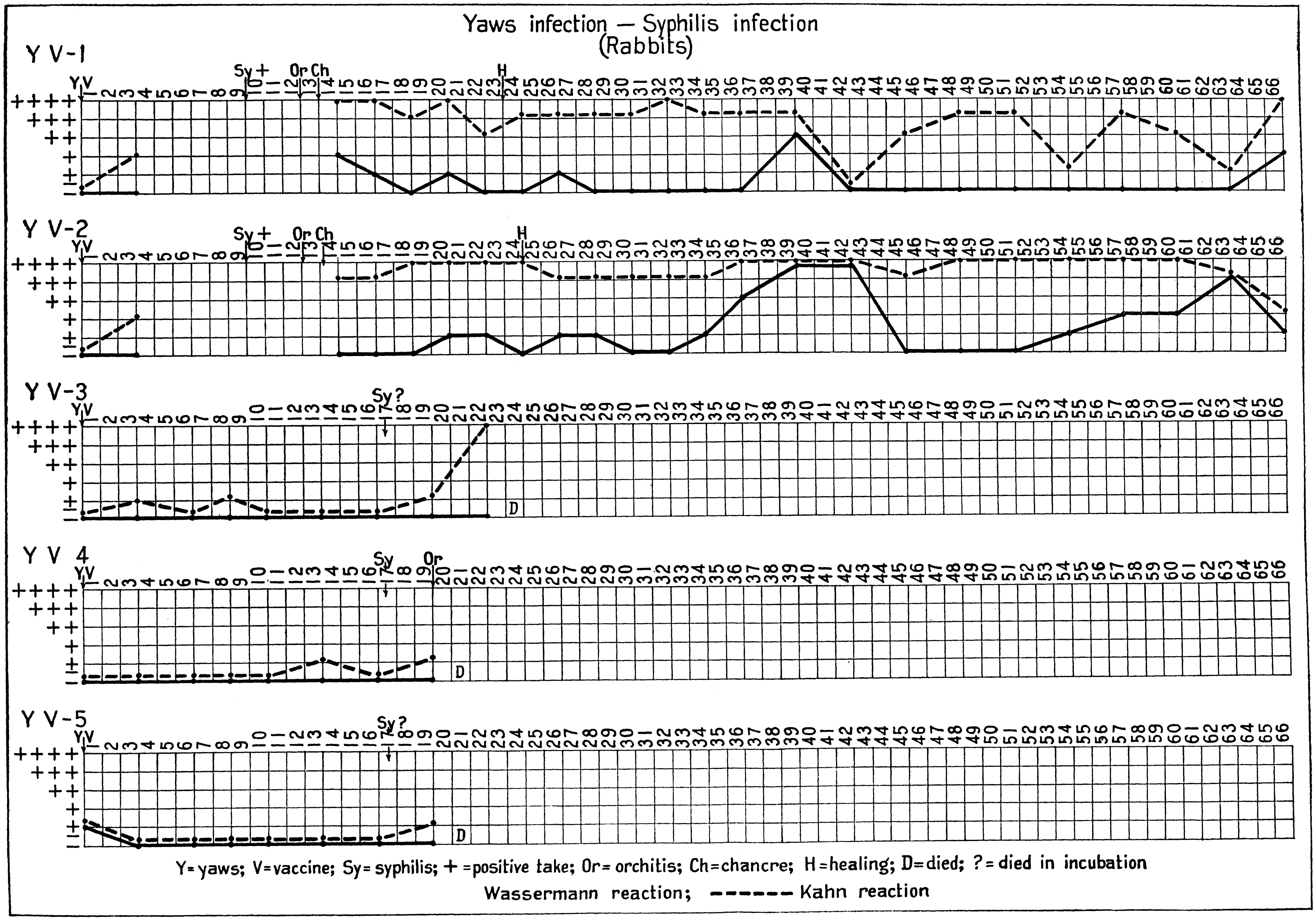

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Fig. 8. Yaws infection = syphilis infection (rabbits). Each square represents one week.

ILLUSTRATIONS

PREVENTIVE IMMUNIZATION AGAINST TREPONEMATOUS INFECTIONS AND EXPERIMENTS WHICH INDICATE THE POSSIBILITY OF ANTI-TREPONEMATOUS IMMUNIZATION[1]

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There is general agreement among all the workers who have attempted to produce active immunity to syphilis in man, monkeys or rabbits. The almost universal experience has been that of failure, no matter what kind of material has been employed as antigen. Extracts of tissue containing treponemas, killed virus, living virus, cultures of treponemas, all as a rule have proved incapable of rendering the animal immune to a subsequent inoculation with virulent organisms. The experiments of Schereschewsky and of Noguchi are too few in number to invalidate this statement. In the few instances in which apparently successful results have been reported after the use of living "attenuated" virus it is by no means certain that the investigators had excluded the possibility that a general infection had been established and that the apparent immunity which they observed was the result of actual infection which had been overlooked. Nor has it proved possible to alter the course of an existing syphilitic infection by immunization with any product derived from cultures of treponemas or from syphilitic tissue. While it is true that Spitzer claimed to have modified the course of syphilis in human beings by active immunization during the early period of the disease with living syphilitic virus, the observations of these workers have not been confirmed and the method has not as yet found any recognized position in the treatment of syphilis.

This brief summary we find in the review of immunity to syphilis written by such an ardent student of experimental syphilis as A. M. Chesney.[4] In the introduction to one of his papers treating on antibody formation against *Treponema pallidum* Hans Zinsser[5] says:

Although active immunization in syphilis has been extensively attempted by many workers, the results seem to show generally unsuccessful experi-

[1] Received for publication, November 15, 1929.

[2] Colonel, Imperial Japanese Army. Colonel Tanabe collaborated in these experiments until his recall May 15, 1928.

[3] Lieutenant Surgeon, Imperial Japanese Navy. Lieutenant Miyao collaborated in these experiments from May 15, 1928.

[4] Immunity in Syphilis. Medicine Monographs 12.

[5] Journ. Exp. Med. 21 (1915) 576.

ments. It is the opinion of Neisser and others that true immunity in syphilis has not so far been demonstrated and possibly does not exist. It seems that a human being is immune to reinoculation only while still diseased, but that susceptibility is again established after clinical recovery. As regards animals experimentally inoculated these matters are still uncertain, because of the unavoidable technical difficulties; for in none of the animals easily and cheaply accessible to most laboratory workers can syphilis be produced in anything like the generalized or prolonged course observed in human beings.

As it is not the purpose at present to give a critical analysis of previous experiments, we may as well stop at these statements of Chesney and Zinsser in reviewing the past attempts at preventive vaccination against treponematous diseases.

It becomes obvious by now, after decades of successful treatment of these diseases, that unless a successful vaccination is at the command of medicine, the time when we can speak of complete control and of hope of eradication of these diseases will remain just as far remote as ever. Syphilis has not diminished substantially in the most progressive countries, in spite of the remarkable advancement of its therapy; and yaws, another disease of the same group and one which is far more amenable to chemotherapy than syphilis, has not been eradicated in any endemic country. We must give in to the realization that no communicable disease can be completely and permanently controlled or eradicated by therapy alone no matter how perfect this may be. Diphtheria and yaws have not been eradicated in spite of the most ideal specific therapy; while smallpox, a disease the therapy of which is nil, can be controlled anywhere if systematic vaccination is carried on.

In face of this admission of little success in controlling the treponematous diseases we must acknowledge the truth of the statement that so far all attempts at working out a method of immunization against these diseases have failed. However, there is a ray of hope in the gloomy outlook into the future. It must be remembered that renowned research workers who have in the past approached the problem of cross immunity between syphilis and yaws either on human subjects or particularly on animals came to most conflicting conclusions. The course of the disease as it occurs in the animals was not sufficiently known, and the various clinical forms of yaws as they occur in man were only very recently duplicated in experimental animals.[6] In the absence of the various clinical forms and

[6] Schöbl, Otto, Philip. Journ. Sci. 35 (1928) 209.

manifestations in experimental animals it was impossible in yaws, for instance, to gauge the degree of infection in individual experimental animals.

It has been known for a long time that in a syphilitic individual or experimental animal, a lesion cannot be produced by inoculation when the infection has lasted for some time. This condition is referred to with a mental reservation by writers as immunity. The hesitancy with which the resistance to inoculation is called immunity is founded on the fact that syphilitic experimental animals, which are resistant to inoculation, may harbour in their body viable treponemas. These findings, made first by Neisser and repeatedly confirmed since, led Neisser to the theory of latent infection. The syphilitic animals cannot be infected because they still have syphilis. Superinfection in the later stage of syphilis is not possible. The animals cannot be cured at that stage of infection; therefore, they cannot be infected. If they are treated within a month and a half they can be cured because they can be reinoculated. The findings of Neisser are facts and valuable information, but the theory of latent infection as an explanation of the resistance to inoculation brought experimental syphilology to a lull, if not to a standstill.

We are firmly convinced that much light can be cast on the problem of syphilis by studying yaws. As in syphilis, so in the later stage of yaws, it has been shown that the animals or man cannot be superinfected. But in yaws animals the period of superinfectability lasts as long as 90 to 150 days in cases of generalized yaws, 180 to 210 days in cases of local yaws, and 150 to 527 days or more from the time of first inoculation, in case that late ulcerative lesions developed.[7] In human subjects, likewise, it was experimentally established that the period of inoculability is about 8 months after inoculation or about 7 months after the appearance of the primary lesion.

We may say that all yaws animals will become resistant sooner or later—those with severe infection sooner; those with low-grade infection later. There is a strong indication in these experiments of a direct relation between the degree of infection and the degree of serologic reactions on the one hand and the degree of resistance to superinfection at a given time on the other hand. Or we may express it as an inverse proportion between the degree of infection and the time necessary for the development of the resistance. This quantitative relation be-

[7] Loc. cit.

tween the degree of infection and the degree of following resistance to inoculation is a point in favor of the argument that the resistance to infection in treponematous diseases is immunity. The failure to find in yaws-immune monkeys treponemas deposited in lymph glands, once the lesion was cured or healed spontaneously, is further corroboration of this point.

The reproduction in monkeys of the different "stages" so called, and of the variety of clinical lesions as found in man made it possible to gauge the severity of infection. The period in yaws of susceptibility to infection is far longer than in syphilis. So long, as a matter of fact, that the first primary lesion may heal without trace of clinical and serologic changes and leave the animal susceptible up to the seventh month after the first inoculation. If the yaws infection in monkeys is terminated before, and not later than the third month by therapy, the animals will remain inoculable. If the infection lasts beyond the third month or is maintained by superinfections beyond that time limit, the animals may go through a stage of higher susceptibility. This period lasts from the third to and inclusive of the fifth month. Or the animals may develop late ulcerative lesions, so-called "tertiary." This may happen during and beyond the sixth month limit. The hypersensibility (negative phase) and the allergic condition of late clinical manifestations are easily recognizable signs of immunity. The treponemas frambœsiæ were found in the lymph glands while the lesion was florid and the monkeys were fully susceptible to yaws, but when the lesion had healed, the animals became resistant with or without treatment, and the treponemas were no longer found in the lymph glands.[8]

The survival of viable treponemas in the lymph glands of syphilitic animals is a phenomenon analogous to the survival of the treponemas in frambœsic skin lesions for months after the onset of the resistance. These questions belong to the problem of healing of treponematous lesions and not to the problem of resistance.

The law of inverse proportions, as established in syphilis by Brown and Pearce,[9] is not evident in yaws in the same manner as in syphilis. There is rather an inverse proportion between the time, after the first infection at which the generalization

[8] Loc. cit.

[9] Brown, Wade H., and L. Pearce, Journ. Exp. Med. 33 (1921) 553.

occurs, and the duration of the cropping out of the metastatic lesions. That is to say, in yaws the earlier after the inoculation the generalization so-called "secondaries" takes place the more typical the metastatic lesions will appear and the longer the cropping out of new metastatic lesions will continue. If the generalization takes place in the fifth month, so to speak at the eleventh hour of the stage of susceptibility, the period of the appearance of crops of metastatic yaws will be short and the metastatic lesions will be predominantly frambœsides. In human syphilis the onset of immunity is so much more sudden and earlier than in yaws, that the metastatic lesions never have the character of the primary lesion that is a chancre. At the best they appear as papulocrustous syphilides, efflorescences which resemble the primary lesion that appears at the point of reinoculation in partially immune animals or man. In yaws, on the contrary, the period of susceptibility is so long that the metastatic lesions, provided the generalization takes place early, develop undisturbed and uninfluenced by the oncoming immunity for a long time. All of which tends to show that the resistance following the infection is due to the first primary lesion but is reënforced in yaws by extensive exacerbation and by the generalization of the process. The epiblastotropic tendency of treponema frambœsiæ as contrasted with the mesoblastotropic preference of the treponema luis is responsible for the leisurely mobilization against the epiblastotropic treponema frambœsiæ and the hasty response of the body organism to the invasion of the treponema luis, as if Nature was well aware of the efficacy of chemotherapy towards treponemas located in the skin and of the relative helplessness of the same chemotherapy to sterilize mesoblastic tissues.

EXPERIMENTS CONCERNING VACCINATION AGAINST YAWS

In the course of experimental investigation of yaws in Philippine monkeys [10] it was observed that sometimes, even though rarely, the inoculation of viable yaws material by means of intradermal injection failed to produce a typical yaws lesion. Instead a rather deep infiltration resulted without apparent pus formation. This induration persisted for some time and ultimately disappeared. When such animals were inoculated later again they failed to take repeatedly. This observation lead one of us

[10] Op. cit.

to perform the experiment already published,[11] in which it became apparent that monkeys can be immunized to yaws by subcutaneous injections of viable treponemas of yaws without the occurrence of any clinical lesion whatsoever. The serologic study [12] on various clinical forms of experimental yaws in monkeys revealed the direct proportion between the severity of infection and the strength of Wassermann reaction. It also showed the direct proportion between the severity of infection, as judged by generalization of the yaws process, and the rapidity of the development of immunity as well as its degree. When it became known [13] that repeated subcutaneous injections of heated yaws "vaccine" may be followed by positive serologic reactions, the next natural step was to test for resistance to infection the animals that were immunized with the yaws "vaccine." The experiments performed with this view are the subject of this paper.

TECHNIC OF THE EXPERIMENTS

The suspension of treponemas in salt solution was used as such for immunization or it was heated on a water bath at 60° C., 80° C., or 100° C. for one hour. This vaccine was used as soon as prepared. Some animals were given only one subcutaneous injection, others received two, three, four, or more vaccinations at about weekly intervals. At intervals of time after the first vaccination, the animals were infected with viable treponema frambœsiæ by intradermal injection. To avoid technical failures of takes the animals were infected in two places, that is to say on both eyebrows, or on the eyebrow and the scrotum. Normal control animals were infected at the same time by the same method and with the same amount of the same inoculum. The details are given in the tables.

INTERPRETATION OF EXPERIMENTAL FINDINGS

If the immunized animal developed a yaw at the point of inoculation the test was considered as valid. If the immunized animal showed no take at all but control healthy animals infected at the same time and with the same yaws material developed a clinical yaw which contained treponemas the test was considered as valid. If the immunized animal showed no sign

[11] Op. cit. 295.
[12] Op. cit. 261.
[13] Philip. Journ. Sci. 40 (1929) 53–89.

of yaws when infected and one of the healthy control animals infected with the same material at the same time failed to develop a yaws lesion, the test was not considered and the particular immunized animal was subjected to another test. All of the vaccinated animals reported in this paper were given a total of at least two valid negative tests.

If it so happened that the animal died without having reached the end of incubation of the second test, it is noted in the tables. If the animal happened to die in the incubation of the first test, the experiment was not considered. The successive infections were performed at intervals of about one month, and the immunized animals that stood the test for immunity were kept under observation and weekly inspections for several months. The length of observations is given in the tables.

The protocols and the results of the experiments are tabulated for the sake of convenience. As shown in these tables four kinds of vaccine have been applied; namely,

1. Unheated vaccine.
2. Vaccine heated to 60° C. for one hour.
3. Vaccine heated to 80° C. for one hour.
4. Vaccine heated to 100° C. for one hour.

SUMMARY OF EXPERIMENTS

One of the monkeys (D–13) used in the experiments and immunized with unheated yaws vaccine was found susceptible six weeks after the first and one week after the last vaccination. This animal received four vaccinations with unheated vaccine. One animal (E–41) that received only one vaccination with heated vaccine (60° C.) was found susceptible four weeks after the vaccination while his mate in the same experiment proved to be resistant. This seeming discrepancy is to be expected, because we have noticed in singly successfully infected monkeys that what may be called a negative phase may develop in certain experimental animals. This negative phase manifests itself in generalization of the local yaws process, which entitles us to the explanation that the natural resistance of the monkey is lowered during the initial period and the yaws process may gain the upperhand. Furthermore, monkeys that have gone through actual infection and were superinfected in the sixth month after inoculation, that is to say on the border line of inoculability, showed similar individual variations. The rest of the monkeys

immunized with unheated vaccine or with 60° C. vaccine stood at least two valid tests in the course of the first six months after the first inoculation with living virus.

Then we extended our immunization experiments to the use of yaws vaccine heated at 80° C. and at 100° C. for one hour. The results of these experiments showed that the yaws vaccine upon exposure to high temperatures lost its potency.

The results in the group of the three animals in particular that received five injections of yaws vaccine heated at 80° C. for one hour are significant. The infection by intradermal inoculation as a test for immunity was performed about twenty weeks or about five months after the first vaccination. Assuming, as previous experiments seem to indicate, that by the vaccination the period of incubation and the early stage of the initial local yaw are set aside and the animal is placed by the vaccination from the start in the third month of the disease, with regard to immunity, the animals immunized with 80° C. vaccine should be immune. The period of five months after the first vaccination corresponds to the seventh month with regard to immunity of infected nonvaccinated monkeys. This shows plainly that the vaccine heated at 80° C. or at 100° C. for one hour lost all or a great deal of its potency.

The possibilities of error in the interpretation of the findings just presented were considered.

The first possibility is that the treponemas present in the vaccine were not killed and consequently the vaccination produced an occult infection. This objection to the interpretation of these findings cannot be admitted on the ground of our knowledge of the viability of treponema frambœsiæ. Yasuyama,[14] in this laboratory, studied experimentally the viability of treponema frambœsiæ (the same strain as used in these experiments) and found that the treponemas will not survive longer than one hour outside of the body at room temperature (28.5° C.). They survived longer at 37.5° C. and at low temperatures died within fifteen minutes. Considering the low resistance of the treponemas of yaws to the adverse conditions on the one hand, and the high temperature (60° C.) to which the vaccine was exposed for one hour on the other hand, it is certain that the treponemas in our vaccines were dead. When injected intradermally the heated vaccine failed to produce yaws in every instance.

[14] Philip. Journ. Sci. **35** (1928) 333.

Another possibility of error is that using a small amount of inoculum for the test of immunity by infection, the treponemas were so few that they failed to produce infection in the inoculated animals recognizable as such by the local lesion. This possibility of error was checked in our experiments by repeated tests and by including with each inoculation of the vaccinated animals normal control monkeys.

The third possibility and the only one to be considered with any degree of seriousness is that the first inoculation as a test for immunity failed to develop a yaw but developed an induration which was followed later by development of immunity such as was noticed in monkeys which received live vaccine subcutaneously. Considering this possibility we have attempted to crowd the tests for immunity within six months after the first test by inoculation so as to avoid this error. According to our experience with yaws monkeys we could not expect that immunity would develop earlier than six months following an intradermal inoculation of a small amount of living treponemas such as was used for these tests. The vaccinated monkeys received a far larger amount of treponemas in the vaccine than by inoculation as a test for immunity. It would, furthermore, be very strange that it should happen in the great majority of the animals vaccinated with unheated or 60° C. freshly prepared yaws vaccine and not in the controls nor in those treated with vaccine heated to 80° C. and to 100° C. It must be admitted that the inoculation of live material, as a test for immunity, in vaccinated animals reënforces the immunity which resulted from the vaccination. The rise in the degree of serologic reactions following the unsuccessful inoculation of immune animals seems to indicate this. Even though it may be true that the immunity is reënforced by subsequent inoculation as a test for immunity, there is no other way known to us of testing the existing immunity except by inoculation with living virus. It is true that occasionally one of the controls failed to develop clinically recognizable yaw, indicating that there may have been insufficient treponemas in the yaws material to produce an infection. However, we have carefully investigated the material to be used for immunity test and in every instance found the treponemas present in the inoculum. These failure-controls were temporary, and when infected later within six months after the first infection these failure-controls invariably took, developing clinically recognizable yaw with demonstrable treponemas in the lesion. In only very few cases we found that these failure-controls that

had developed a swelling after the first infection proved to be immune when reinfected six months or more after the first infection. Furthermore, we have checked against the failure-takes in the vaccinated animals by inoculating in each test the same animal in at least two places. We are at the end of our wits to think of any other explanation for the failure of producing yaws lesion in the vaccinated animals that would be anything else but immunity, particularly in consideration of the quantitative relation of the number of vaccinations to the degree of serologic reactions. In other words, the vaccinated animals in our experiments behaved with regard to serologic findings and resistance to infection like those monkeys that have gone through actual infection, developed generalized yaws and healed, but the vaccinated monkeys never showed a sign of infection.

DISCUSSION

Aside from the surprising finding that, according to these experiments, killed treponemas produced immunity, the most striking feature was that the immunity set in so early and so suddenly as a consequence of vaccination, while it took six months in a case of actual disease (local yaw) before complete immunity developed.

If previous experimental data had not been available this seeming discrepancy might have cast a shadow of discouraging suspicion on the entire experimental procedure. Fortunately, we were in possession of results of experiments undertaken previously by one of us and already published.[15]

For the convenience of the reader the tabulated results of the experiments concerning immunity in generalized experimental yaws monkeys are given in Table 11.

Of the six animals included in this experiment we wish to point out monkey T–1 and, particularly, monkey G–6. Briefly analyzed the experiment is as follows:

T–1. The animal was inoculated with yaws and developed in due time a local yaw at the point of inoculation. It was again inoculated with living yaws material in the first month after the first inoculation. The second inoculation resulted again in a typical local yaw. In the third month after the first inoculation a vigorous local exacerbation developed in the second yaw. In

[15] Op. cit. 286.

the fourth month after the first inoculation a third inoculation with living yaws material was performed, following which generalized yaws appeared during the same month. The third inoculation, performed so to speak immediately before the appearance of metastatic clinical yaws, failed to produce any lesion at all as did the fourth inoculation three months later. This shows that the animal became immune following the clinical manifestation of the generalization in less than one month, which is the incubation period of local yaw following experimental inoculation in Philippine monkeys or man, or less than two months after the exacerbation of the local yaw.

TABLE 11.—*Showing the development of immunity in monkeys with generalized yaws.*[a]

[+, positive take after superinfection; —, negative take after superinfection; exac, exacerbation; gen, generalization; reg met, regional metastases.]

Designation of monkey.	Result of first inoculation.	Months after original inoculation.									
		1	2	3	4	5	6	7	8	9	10
P-8	Initial local yaw	----	----	----	+	gen	----	----	—	----	----
N-8	do	----	exac	reg met	gen	----	—	----	----	—	----
T-1	do	+	----	exac	— gen	----	----	—	----	----	----
G-6	do	----	+ — exac	— gen	—	----	----	----	----	----	----
C-3	do	----	----	----	+	exac gen	—	----	----	----	----
E-15	do	+	----	----	exac	gen	----	----	—	----	----

[a] The symbols are placed in the months in which the superinfection, the exacerbations, or the generalization took place.

Monkey G-6 was inoculated with yaws and in about four weeks developed a local yaw at the place of inoculation. The animal was inoculated again successfully in the early part of the second month after the first inoculation. However, the third inoculation, performed on this animal in the latter part of the same month and immediately before the local exacerbation, failed to produce a lesion. Likewise, the fourth inoculation following the exacerbation and placed immediately before the appearance of general manifestation failed as did the fifth one performed less than a month after the breaking out of generalized lesions.

In the very first experiment concerning subcutaneous immunization with live treponema frambœsiæ as already published,[16] it became known that the immunity may set in later than one week and sooner than three months after the vaccination which is far less than the time necessary for immunity to develop in the natural course of the disease in monkeys.

These experimental facts corroborate the findings of early onset of immunity in some vaccinated animals and explain a phenomenon which at first thought may seem unbelievable. To repeat the statement of one of us made on a previous occasion: by vaccination we set aside the period of incubation and the early stage of initial lesion and placed the animal from the start into the second or third month of the disease.

CONCLUSIONS

We have in these experiments indicated a procedure, unique of its kind, in treponematous diseases and unsurpassed in preventive immunization of any disease, whereby through the use of killed and harmless vaccine an immunity of long duration may be induced in experimental animals more rapidly than by the most severe infection.

THE EFFECT OF SPECIFIC TREATMENT ON THE IMMUNITY PRODUCED BY YAWS VACCINATION AND THE RELATION OF THIS IMMUNITY TO SYPHILIS

That specific treatment with neosalvarsan sterilizes the body organism of monkeys infected with yaws but that it has no effect on the immunity to yaws, once it is established, has been pointed out on a previous occasion.[17] It was also shown that the immunity will follow a local yaws infection if the treatment is delayed beyond the second month after the inoculation.[18] Monkeys immunized with live or killed yaws vaccine in such a manner that no lesion developed were found repeatedly immune to intradermal inoculation with yaws.[19] Monkeys found repeatedly immune to yaws as a consequence of yaws infection were found immune to syphilis as well.[20]

[16] Op. cit. 295, Table 15.

[17] Philip. Journ. Sci. 35 (1928) 291.

[18] Ibid. 293.

[19] Antea 219.

[20] Philip. Journ. Sci. 40 (1929) 91.

TABLE 1.—*Subcutaneous immunization against yaws; unheated vaccine used fresh.*

[+, positive take, clinically and microscopically; —, no take, clinically and microscopically; 0, not done; D, died.]

Designation of monkey.	Subcutaneous immunization.				Intradermal infection with yaws.						Infection, weeks after immunization.		Observed until—
	First.	Second.	Third.	Fourth.	First.		Second.		Third.		First.	Last.	
					Date.	Result.	Date.	Result.	Date.	Result.			
D-13	II-3-27	II-10-27	II-18-27	III-9-27	III-15-27	+					6	1	V-15-29
Control	0	0	0	0	III-15-27	+							
D-12	II-3-27	II-10-27	II-18-27	III-9-27	VI-4-27	—	IX-10-27	—	II-6-28	—	17	12	D III-21-29
N-12	II-3-27	II-10-27	II-18-27	III-9-27	VI-4-27	—	IX-10-27	—	II-6-28	—			D III-21-29
Control	0	0	0	0	VI-4-27	+	0		0				
Do	0	0	0	0	0		IX-4-27	+	0				
Do	0	0	0	0	0		0		II-6-28	+			
W-37	II-1-28	II-6-28	II-18-28	0	VI-21-28	—	VII-19-28	—	X-20-28	—	20	18	VII-1-29
Control	0	0	0	0	VI-21-28	+	0						
Do	0	0	0	0	0		VII-19-28	+					
Do	0	0	0	0	0		0		X-20-28	+			
W-38	II-1-28	II-6-28	0	0	VI-25-28	—	VII-19-28	—	X-20-28	—	20	19½	VII-1-29
Control	0	0	0	0	VI-25-28	+	0						
Do	0	0	0	0	0		VII-19-28	+					
Do	0	0	0	0	0		0		X-20-28	+			
W-39	II-1-28	0	0	0	V-3-28	—	VI-25-28	—	VII-19-28	—	13	13	D II-20-29
Control	0	0	0	0	V-3-28	+	0						
Do	0	0	0	0	0		VI-25-28	+					
Do	0	0	0	0	0		0		VII-19-28	+			

TABLE 2.—*Subcutaneous immunization against yaws. Vaccine heated at 60°C. for one hour, used fresh.*

[+, positive take, clinically and microscopically; —, no take, clinically and microscopically; 0, not done; D, died.]

Designation of monkey.	Subcutaneous immunization.			Intradermal infection with yaws.						Infection, weeks after immunization.		Observed until—
				First.		Second.		Third.				
	First.	Second.	Third.	Date.	Result.	Date.	Result.	Date.	Result.	First.	Last.	
U-1	VII-27-27	VII-30-27	VIII-3-27	IX-17-27	—	III-9-28	—	IV-23-28	—	7	6	VII-1-29
Control	0	0	0	IX-17-27	+							
Two controls	0	0	0	0		III-9-28	++					
Control	0	0	0	0		0		IV-23-28	+			
W-3	IX-22-27	IX-28-27	X-10-27	I-31-28	—	III-9-28	—	IV-23-28 VI-4-28[a]	— —[a]	18	16	D XII-24-28
Control	0	0	0	I-31-28	+	0		0				
Two controls	0	0	0	0		III-9-28	++	0				
Control								IV-23-28	+			
Two controls								VI-4-28	++			
W-15	XI-21-27	XI-28-27	XII-5-27	II-7-28	—	III-9-28	—	IV-23-28	—	10½	9½	VII-1-29
Control				II-7-28	+							
Two controls				0		III-9-28	++	0				
Control				0		0		IV-23-28	+			
W-22	I-18-28	I-31-28	II-8-28	II-27-28	—	IV-23-28	—	VI-4-28	—	6	3	D IX-3-28
W-23	I-18-28	I-31-28	II-8-28	II-27-28	—	IV-23-28	—	VI-4-28	—			VII-1-29
Two controls				II-27-28	++							
Control						IV-23-28	+					
Two controls								VI-4-28	++			
W-25	I-20-28	I-31-28	0	II-27-28	—	V-3-28	—	VI-25-28	—	5	4	VII-1-29
W-26	I-20-28	I-31-28	0	II-27-28	—	V-3-28	—	VI-25-28	—	5	4	D X-8-28
W-27	I-20-28	I-31-28	0	II-27-28	—	V-3-28	—	VI-25-28	—	5	4	VII-1-29
Two controls				II-27-28	++	0		0				

Control				0		V-3-28	+	0				
Do								VI-25-28	+			
E-40	II-1-28	0	0	II-28-28	—	V-3-28	—	VI- 4-28 VI-25-28[a]	— —[a]	4	4	D VIII-29-28
E-41	II-1-28	0	0	II-28-28	+			0		4	4	
Control				0		V-3-28	+	0				
Two controls				0		0		VI-4-28	++			
Control				0		0		VI-25-28	+			
W-20	I-4-28	I-10-28	0	I-31-28	—	IV-23-28	—	VI-25-28	—	4	3	D VII-13-28
Control				I-31-28	+	0		0				
Do						IV-23-28	+	0				
Do								VI-25-28	+			
W-7	X-24-27	X-31-27	XI-8-27	XII-12-27	—	I-18-28				6	4	D I-30-28
Control				XII-12-27	+							
W-17	XII-12-27	XII-18-27	0	I-18-28	+					5	4	III-18-28
Control				I-18-28	+							

[a] Fourth intradermal infection with yaws.

TABLE 3.—*Subcutaneous immunization against yaws. Vaccine heated at 80°C. for one hour, used fresh.*

[+, positive take, clinically and microscopically; —, no take, clinically and microscopically; 0, not done.]

Designation of monkey.	Subcutaneous immunization.				
	First.	Second.	Third.	Fourth.	Fifth.
W-57	III-5-28	III-12-28	III-20-28	V-30-28	VII-17-28
W-59	III-5-28	III-12-28	V-30-28	VII-17-28	0
W-61	III-5-28	V-30-28	VII-17-28	0	0
D-4	V-14-28	VI-22-28	VI-30-28	VIII-4-28	0
Control	0	0	0	0	0

Designation of monkey.	Intradermal infection with yaws.		Infection, weeks after immunization.	
	Date.	Result.	First.	Last.
W-57	VII-31-28	+	20	2
W-59	VII-31-28	+	20	2
W-61	VII-31-28	+	20	2
D-4	XII-11-28	+	24	8
Control	VII-31-28	+		

TABLE 4.—*Subcutaneous immunization against yaws. Vaccine heated at 100°C., used fresh.*

[+, positive take, clinically and microscopically; —, no take, clinically and microscopically; 0, not done.]

Designation of monkey.	Subcutaneous immunization.			Intradermal infection.		Infection, weeks after immunization.	
				First.			
	First.	Second.	Third.	Date.	Result.	First.	Last.
A-8	IV-11-28	IV-16-28	IV-27-28	VI-21-28	+	10	8
Control	0	0	0	VI-21-28	+		
K-9	IV-11-28	IV-16-28	IV-27-28	VI-26-28	+	11	9
Control	0	0	0	VI-26-28	+		
J-18	IV-16-28	IV-27-28	0	VI-26-28	+ [a]	9	8
Control	0	0	0	VI-26-28	+		

[a] Clinical lesion.

TABLE 5.—*Showing that neosalvarsan treatment has no effect on the immunity to yaws produced by vaccination.*

[+, typical lesion; —, no lesion; 0, not done.]

Designation of monkey.	Yaws vaccine 60° C.			Infected with yaws. Results and dates.			Neosalvarsan.	Reinfected with yaws. Results and dates.		Neosalvarsan.	Reinfected with yaws.
W-23	I-18-28	I-31-28	II-8-28	— II-27-28	— IV-23-28	— VI-4-28	0.18 gram VIII-3-28	— IX-17-28	— X-22-28	0.01 gram XII-14-28	— I-7-29
W-25	I-20-28	I-31-28	0	— II-27-28	— V-3-28	— VI-25-28	VIII-3-28	— IX-17-28	— X-22-28	XII-14-28	— I-7-29
W-27	I-20-28	I-31-28	0	— II-27-28	— V-3-28	— VI-25-28	VIII-3-28	— IX-17-28	— X-22-28	XII-14-28	— I-7-29
Controls	0	0	0	+ II-27-28	+ IV-23-28	+ VI-4-28	0	+ IX-17-28	+ X-22-28	XII-14-28	0
				0	+ V-3-28	+ VI-25-28	0	0	0	0	++ I-7-29
	Yaws vaccine unheated.										
W-37	II-1-28	II-6-28	II-18-28	— VI-21-28	— VII-19-28	— X-20-28	0.2 gram XI-29-28	— I-7-29	0	0	0
W-38	II-1-28	II-6-28	0	— VI-25-28	— VII-19-28	— X-20-28	XI-29-28	— I-7-29	0	0	0
W-39	II-1-28	0	0	— V-3-28	— VI-25-28	— VII-19-28					
Controls	0	0	0	+ V-3-28 0	+ VI-21-28 + VII-19-28	+ VI-25-28 + X-20-28	0	++ I-7-29	0	0	0

It was quite natural, therefore, to investigate the effect specific treatment may have on the immunity to yaws gained by vaccination and to probe the immunologic relation between the vaccination immunity against yaws and syphilitic infection.

As many of the animals as were still available from previous vaccination experiments were treated with neosalvarsan and reinfected with yaws. This procedure was repeated, following which the animals were infected with syphilis. The results of the inoculations with yaws and syphilis were observed and at intervals of time, indicated in the table, the inguinal lymph glands corresponding to the site of inoculation with syphilis on the scrotum were transplanted to the testicles of rabbits.

The results of the experiment concerning the effect of specific treatment on immunity produced by vaccination are arranged in Table 5. They show that like the immunity achieved by actual infection the immunity produced by vaccination is in no way influenced by specific treatment given after the test for immunity by inoculation with live, virulent treponema frambœsiæ.

In Table 6 are given the results of inoculation with syphilis performed on yaws-vaccinated monkeys which were proven to be immune to yaws before and after the treatment with neosalvarsan. The control monkeys developed typical syphilitic scleroses at the point of inoculations but the yaws-vaccinated monkeys showed no sign of a lesion. They, however, like the controls harbored treponemas of syphilis in the respective inguinal lymph glands.

TABLE 6.—*Showing the results of inoculation with syphilis performed on yaws-vaccinated monkeys which were demonstrated to be immune to yaws before and after specific treatment with neosalvarsan.*

[Previous history of these animals is given in Table 5. +, positive specific lesion; —, no lesion developed; 0, not done.]

Designation of monkey.	Immune or not immune to yaws.	Inoculation with syphilis.		Transplants of lymph glands.	
		Date.	Result.	Date.	Result.
W-23	Immune	I-7-29	—	V-13-29	+
W-25	do	I-7-29	—	IV-26-29	+
W-27	do	I-7-29	—	0	
W-37	do	I-7-29	—	IV-26-29	+
W-38	do	I-7-29	—	0	
I-11 control	Not immune	I-7-29	+	IV-26-29	+
I-12 control	do	I-7-29	+	IV-26-29	+

CONCLUSION

1. Specific treatment with neosalvarsan given after tests for immunity by inoculation has no effect on the immunity produced by yaws vaccination.

2. Immunity to yaws produced by yaws vaccination prevents the development of a specific syphilitic lesion, but does not necessarily prevent the penetration of treponemas of syphilis into the regional lymph glands corresponding to the point of inoculation with syphilis.

EXPERIMENTAL STUDY OF IMMUNOLOGIC RECIPROCITY BETWEEN YAWS AND SYPHILIS, CONSIDERING ALSO OTHER PHASES OF IMMUNITY BESIDES THE COMPLETE RESISTANCE TO INFECTION [1]

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INTRODUCTION

The arrangement of experiments which in the past aimed to solve the immunologic relationship between the two human treponematoses was such that animals inoculated with one of the two diseases, syphilis and yaws, were superinoculated with the other disease at various intervals of time and the results of the superinfection were registered as " immune" when a lesion failed to develop, or "not immune" when the lesion developed from superinoculation. The main objection to those experiments is the failure on the part of the experimenters to prove that the animals were immune to the first disease before their immunity to the other disease was tested. Confusing results were arrived at. When this objection to the past experiments concerning cross immunity was avoided and the animals infected with one disease were repeatedly proven immune to it before they were tested for immunity to the other disease, the results of our experiments were surprisingly uniform and convincing that immunologic reciprocity between the two human treponematoses exists.[2]

In the present experiments additional evidence of this reciprocity came to light, partly through application of a new experimental arrangement by means of which partial or delayed immunity to yaws can be detected.

[1] Received for publication, November 15, 1929.
[2] Philip. Journ. Sci. 40 (1929) 91.

This experimental procedure was suggested by the findings made in our study of serologic reciprocity between yaws and syphilis.[3]

A NEW EXPERIMENTAL PROCEDURE OF TESTING FOR IMMUNITY TO TREPONEMATOUS INFECTIONS

The experimental procedure to be discussed was designed to test for immunity in experimental treponematoses and to study the effect immunization may have on the course of these infections. It led to experimental findings which could not have been made had we adhered to the experimental procedure hitherto applied in the study of immunity and immunization in treponematoses.

The intratesticular inoculation, particularly with syphilis, as useful a method as it is in many respects, does not allow the experimenter to study by successive inoculations the development of immunity. The incubation of the syphilitic lesion in the testicle is variable, at times of long duration particularly in young rabbits, and a unilateral inoculation frequently leads to bilateral orchitis so that the time must be awaited until the lesion has healed before intratesticular superinoculation can be performed again. At times, when superinoculation is performed in the testicle other than the one in which the first inoculation was made, one is not absolutely certain that the lesion that developed at the place of superinoculation was not due to the first inoculation. Exacerbation of experimental syphilitic orchitis is not an infrequent occurrence. We have, therefore, used intradermal inoculation in our experiments with yaws and syphilis. The lesion that develops in consequence of this procedure has a definite and short incubation. The character and the intensity of the lesion can be clinically observed and judged, and numerous successive inoculations can be performed on the same animal.

Hitherto published experiments concerning immunity and immunization in treponematoses have been arranged in such a way that one superinoculation, with the same kind of treponemas or one cross-inoculation with the two kinds, was performed at various periods of time after the first inoculation and if a lesion developed as a result of superinoculation the animals were declared nonimmune. If a lesion failed to develop and the inoculum was proven to contain viable treponemas by simultaneous

[3] Antea 203.

inoculation to normal control animals, the animal was declared immune.

Thus we had in the past only two conditions detectable by the experimental procedure formerly used. In our previous experiments the quantity factor in yaws immunity became clearly evident. It was, therefore, to be expected that between complete resistance and complete susceptibility intermediate degrees of immunity must exist.

The procedure herein discussed simply consists of repeated inoculations at intervals of one or two months.

When a series of immunized animals is to be tested they are inoculated with live treponemas of yaws by intradermal injection. Normal control animals of the same kind are inoculated with the same amount of the same inoculum at the same time. This procedure is repeated every month or two. The immunized animals will fail to take sooner or later, but the normal control animals will remain inoculable with yaws for a far longer time than the immunized ones. Thus, it is possible to detect various degrees of immunity and to demonstrate that immunization has a definite effect on the course of the infection. This experimental procedure was found productive of results not only in the study of immunity to yaws but also in the study of immunologic reciprocity between yaws and syphilis.

THE EFFECT ON IMMUNITY TO YAWS OF SUPERINFECTION WITH SYPHILIS PERFORMED IN YAWS-INFECTED MONKEYS DURING THE PERIOD OF SUPERINFECTABILITY

It has been demonstrated by experiments that Philippine monkeys can be superinfected with yaws before but not after the sixth month counting from the time of the first successful inoculation with yaws.[4]

When yaws-infected monkeys became immune to superinoculation with yaws, they were immune to syphilis as well.[5]

In the experiment herewith presented the effect was studied of superinfection with syphilis on the onset of immunity to yaws in the course of yaws infection. Briefly stated the experiment was as follows:

Four monkeys recently inoculated with yaws in the eyebrow and which developed a local yaw were superinoculated with syph-

[4] Philip. Journ. Sci. 35 (1928) 209.

[5] Philip. Journ. Sci. 40 (1929) 91.

ilis in the scrotum. Two normal monkeys were inoculated as controls at the same time and with the same amount of the same syphilitic material. All of these animals developed typical syphilitic lesions at the point of inoculation. The duration of the syphilitic lesions in the yaws monkeys was somewhat shorter than that of the syphilitic lesions in the normal control animals, but it was still within the limits of individual variations found in experiments on normal monkeys. Before the period of superinoculability with yaws expired and following the inoculation with syphilis, the animals were superinoculated with yaws. One control monkey was inoculated with yaws at the same time. The result of the superinoculation with yaws was the following:

The normal control monkey developed a typical yaw at the place of inoculation in three weeks, but the yaws monkeys that were superinfected with syphilis showed no lesion at the place of superinoculation with yaws. Four weeks later another superinfection with yaws on all the monkeys, including the control yaws monkey, was performed with the following result:

The yaws control monkey again developed a yaws lesion at the place of the second superinoculation with yaws. The yaws monkeys that had been superinoculated with syphilis in the second month of yaws infection and were found immune to yaws in the fourth month were again found immune to yaws in the fifth month of yaws infection.

Yaws-infected monkeys were found inoculable with yaws during the first five months after the original inoculation without exception, while some were immune and some not immune in the sixth month.

DISCUSSION

This experiment brings out additional proof of immunologic reciprocity between yaws and syphilis; at the same time, it shows the fundamental difference in the biology of treponema frambœsiæ and treponema luis.

First of all this experiment demonstrates that yaws monkeys are not immune to syphilis while susceptible to yaws.

Intradermal superinfection with epiblastotropic treponema of yaws performed during yaws infection strengthens the immunity to yaws, but does not hasten it unless the yaws antigen reaches the deep layers of the skin and possibly other organs as is the case when generalization of yaws lesions takes place.

Intradermal inoculation with the mesodermophilic treponema luis, superposed on an infection with the epiblastotropic trepo-

nema of yaws, not only strengthens but also hastens the onset of immunity to yaws, because by its biologic nature the treponema luis rapidly penetrates the tissues and appears in the deep layers of the skin, an occurrence which happens in yaws only when treponemas are thrown into the deep layers of the skin by the blood stream; that is, in case of generalized dissemination of yaws infection. Indeed, inoculation with yaws placed into the deep layers of the skin of normal monkeys produced immunity to yaws more rapidly than yaws infection itself.

The difference between multiple local yaws and multiple metastatic yaws is their pathogenesis.

The local yaws are produced by viable treponemas which were placed by injection into a definite and limited area of susceptible skin. The metastatic yaws are produced by viable treponemas which arrived in the susceptible skin by the blood stream. Leaving the mother yaw they have passed through the lymphatic system into the blood stream and into the capillary system of the various organs. Due to their size and shape the treponemas are necessarily caught in the smallest capillaries. Their shape and motive activity permits them to emigrate into the tissues. This happens in all the organs of the body where a capillary system is present, but only those treponemas that arrive in tissues favorable to their biologic requirements survive and produce specific lesions after due incubation.

In a case of local yaws the treponemas remain for a considerable time in the superficial layers of a limited area of the skin. In generalized yaws, in addition to this, a certain amount of treponema antigen is delivered by the blood stream to all organs, including the skin, in the form of viable treponemas that do not survive to produce lesions or in the form of antigen liberated from them. The enumeration of the tissues that are responsible for immunization in the course of treponematous infections is impossible at present to make. There is, however, experimental evidence which in the case of yaws incriminates the skin and eliminates serous cavities, the muscles, and the lymphatics. The reason, therefore, for the difference in degree of immunity at a given time in animals with multiple local yaws and animals with the same number and extent of metastatic yaws is the clinically invisible infection of the skin outside of the lesions. Our successful experiments on immunization against yaws by subcutaneous injections of treponema antigen without production of lesions support this explanation. The

fundamental biologic difference between the treponema of yaws and that of syphilis with regard to organotropism comes again to view in the difference between the immunologic conditions produced by treponema frambœsiæ and those produced by treponema luis.

CONCLUSIONS

1. Yaws-infected monkeys are susceptible to cutaneous infection with syphilis during the early stage of yaws during which they are susceptible to yaws.
2. Superinfection with syphilis of yaws-infected monkeys hastens the onset of immunity to yaws.
3. This phenomenon brings further proof of immunologic relationship between yaws and syphilis and shows that the biologic difference between treponema frambœsiæ and treponema luis is one of organotropism, or tissue selectivity.

TABLE 1.—*Showing the results of inoculations with syphilis performed on monkeys that were successfully inoculated with yaws less than six months before and were not immune to yaws at the time of inoculation with syphilis. The effect of this cross superinfection on the immunity to yaws is also shown.*

[+, typical lesion; —, no lesion; 0, not done; D, died.]

Designation of monkey.	Inoculation with yaws.		Date of lesion.		Inoculation with syphilis.	
	Date.	Result.	Appeared.	Healed.	Date.	Result.
F-37	III-21-29	+	V-8-29	VI-27-29	V-27-29	+
E-43	IV-8-29	+	V-17-29	VI-27-29	V-27-29	+
L-13	III-4-29	+	IV-8-29	VI-13-29	V-27-29	+
O-c-1	III-21-29	+	IV-24-29	VII-31-29	V-27-29	+
O-c-2	III-21-29	+	V-25-29	VI-13-29	V-27-29	+
SYD-19; control	0	0	0	0	V-27-29	+
SYD-20; control	0	0	0	0	V-27-29	+
YB-9; control	0	0	0	0	0	0

Designation of monkey.	Date of lesion.		Superinfection with yaws.			
	Appeared.	Healed.	Date.	Result.	Date.	Result.
F-37	VI-7-29	VIII-8-29	VII-17-29	—	VIII-16-29	—
E-43	VI-7-29	D VI-29-29	0	--------	0	--------
L-13	VI-13-29	VII-31-29	VII-17-29	—	VIII-16-29	—
O-c-1	VI-7-29	VII-31-29	VII-17-29	—	VIII-16-29	—
O-c-2	VI-7-29	VII-31-29	VII-17-29	—	VIII-16-29	—
SYD-19; control	VI-7-29	VIII-8-29	0	--------	0	--------
SYD-20; control	VI-7-29	VIII-8-29	0	--------	0	--------
YB-9; control	0	0	VII-17-29	+	VIII-16-29	+

TABLE 2.—*Showing that superinoculation with yaws of yaws-infected monkeys does not hasten the onset of immunity to yaws.*

[Philippine Journal of Science 35 (1928) 285, Table 10.]
[+, typical take; ±, feeble take; —, no take.]

Designation of monkey.	Months after original inoculation.											
	1	2	3	4	5	6	7	8	9	10	11	12
G-7		+		+	±	—						
F-13		+		+								
E-13		+				+						
K-2			+		+		—		—			
B-1			+			+				—		—
B-2			+			+				—		—

THE RELATIONSHIP BETWEEN YAWS AND SYPHILIS WITH REGARD TO THE NEGATIVE PHASE WHICH IS RESPONSIBLE FOR THE OCCURRENCE OF EXACERBATIONS IN TREPONEMATOSES AND AN OBSERVATION REGARDING THE FATE OF TREPONEMAS OF YAWS IN THE BODY OF YAWS-IMMUNE ANIMALS

When yaws-inoculated Philippine monkeys were superinfected with yaws during the third, fourth, or fifth month after the original inoculation, a certain portion of these animals developed, as a consequence and at the place of superinfection, lesions that were far more intensive and extensive and contained far more treponemas than the lesions that developed after the first inoculation. In other animals thus superinfected the vanishing original yaws lesion exacerbated in a like manner. Still other animals showed within the time limit indicated above, extensive exacerbations without ever having been subjected to superinfection. These experiments have been already published and were made repeatedly since their publication.[6]

During our study on Philippine monkeys concerning the relationship between yaws and syphilis a phenomenon was observed which seems to be of importance. A monkey was inoculated on the left eyebrow with our strain of yaws (Kadangan). When the usual period of incubation expired no sign of a lesion was noticed at the place of inoculation. The animal was inoculated at the same place with Nichols strain of syphilis. Little

[6] Philip. Journ. Sci. 35 (1928) 230, 236.

more than two weeks after the inoculation with syphilis a lesion developed at the place of the two inoculations. The lesion was elevated, oozing, and contained fairly numerous treponemas. The character of the lesion was that of an initial local yaw, but the base of the lesion was indurated, a sign never observed before or since in hundreds of yaws-inoculated monkeys. Knowing the past history of the experimental animal we suspected that in this case a coexisting infection with yaws and syphilis may have developed and that the inoculation with syphilis provoked the formation of a yaws lesion at the place of previous inoculation with yaws. With the purpose of studying this phenomenon the following experiment was arranged and carried out:

A series of monkeys recently inoculated with yaws, in which the lesions healed or nearly healed, were inoculated with syphilis. One of the monkeys showed a dry vanishing lesion at the time of inoculation with syphilis. This yaws lesion presented at that time a narrow, dry, semicircular lesion on the scrotal skin. In the center of this semicircle the intradermal inoculation with syphilis was placed. A typical syphilitic lesion developed at the place of inoculation and simultaneously the vanishing yaws lesion exacerbated, changing into a rather extensive, active, spreading yaw.

These two instances, although suggestive, may be interpreted as a mere coincidence and without any causal dependence. In two other instances we made observations which are more convincing of the immunologic relationship between yaws and syphilis with regard to the negative phase than are the two cases already mentioned.

It concerned two monkeys immunized with heated yaws vaccine. Both animals were repeatedly tested for immunity to yaws by means of intradermal inoculation with virulent, viable yaws material and were found immune to yaws.

The first animal (W–3)[7] received three subcutaneous injections of yaws vaccine rich in treponemas and heated one hour at 60° C. between September 22, 1927, and October 10, 1927. This animal was tested and found immune to yaws January 31, 1928, March 9, 1928, April 23, 1928, and again June 4, 1928. No sign of a lesion was ever noticed from the time of the first inoculation. June 15, 1928, the animal was inoculated with syphilis. No le-

[7] Antea, Preventive immunization, etc., p. 219.

sion developed at the place of this inoculation, but September 13, 1928, a typical yaws lesion was found at the place of the last inoculation with yaws. The second monkey (W–25)[8] was vaccinated with killed yaws vaccine two times between January 20, 1928, and January 31, 1928. The tests for immunity to yaws by intradermal inoculation with virulent yaws material were performed February 27, 1928, May 3, 1928, and June 25, 1928. Between August 3, 1928, and August 22, 1928, neosalvarsan was given. This monkey was inoculated with yaws again, without a take, September 17, 1928, and October 22, 1928. Another neosalvarsan treatment was given between December 14, 1928, and December 28, 1928, following which the animal was again inoculated with yaws January 7, 1929. No lesion developed at any of the places of yaws inoculations, and the animal was inoculated with syphilis March 20, 1929. No lesion developed at this place of inoculation with syphilis, but May 10, 1929, a typical but short-lived yaw, containing treponemas, was found at the point of the last inoculation with yaws.

SUMMARY

When Philippine monkeys infected with yaws were inoculated with syphilis at a time when the early local yaw just healed or nearly healed one of the animals showed considerable exacerbation of the vanishing yaws lesion after the inoculation with syphilis which was followed by development of syphilitic lesion.

When a series of Philippine monkeys, immunized by killed yaws vaccine and which were proven to be immune to yaws, were inoculated with syphilis no syphilitic lesion developed at the place of inoculation, but following the inoculation with syphilis typical yaws lesion developed in two animals three and four months, respectively, after and at the place of the last unsuccessful inoculation with yaws.

DISCUSSION

As far as our own experiments on Philippine monkeys go there were four conditions found in these animals with regard to reactivity of the body tissues to the inoculation with treponemas of yaws. There was a definite and within the limit of individual variations constant relation between each of the four

[8] Antea 219.

conditions and the aggressivity of the same strain of treponemas under these conditions of tissue reactivity. By aggressivity is meant the ability of the parasite to multiply at the place of inoculation and to invade body tissues either by the lymphatic system or by the blood stream. The intensity and extent of the lesion as well as the number of the parasites encountered in the lesion are signs by means of which the invasive ability of the treponemas can be judged.

The conditions of the tissue reactivity are:

1. First is the normal condition of tissue reactivity in the animals under discussion. As a result of a single inoculation with yaws the monkey develops a local yaw only. The yaw runs its course and heals, by which process the infection is terminated. A fair number of treponemas is found in such a lesion at the height of its development.

2. The second condition is the state of higher susceptibility or a negative phase. Due to timely performed superinfection with yaws of yaws-infected monkeys, rarely spontaneously, a local lesion develops of unusual extent and intensity. It contains enormous numbers of treponemas. The treponemas are broadcast through the lymphatic and blood highways in this condition, and produce, after due incubation, metastatic, generalized manifestations of yaws.

3. Third is the condition of allergic state in which the body tissues react by excessive granulation and necrosis at the point of inoculation or at the place of residual yaws lesions. Very few treponemas, indeed, or none at all are found in such lesions and they do not propagate metastatically. They were never observed to develop spontaneously in monkeys but were produced in yaws animals by superinfection with yaws.

4. Fourth is the complete nonreactivity of body tissues to the incorporation of viable and fully virulent treponemas.

The last-mentioned condition, which we may define as an ability on the part of the body organism to suppress the parasite into a state of saprophytism, is the ultimate goal of the host's struggle with the parasite. There being no mortality to yaws, this goal is invariably reached sooner or later. Before this is accomplished, however, there are many setbacks suffered by the host.

Our study of yaws in monkeys has demonstrated clearly that what may be called "switching" from one into the other of the

conditions of tissue reactivity takes place during yaws infection.

The first condition, the normal tissue reactivity, may last for six months, then it is transformed into the state of complete tissue nonreactivity.

The first condition may be "switched" into the negative phase by superinfection, rarely spontaneously; generalized yaws is the result, following which the reactivity of the tissues is rapidly transformed into the ultimate state of complete nonreactivity, the "pium desideratum" of the host.

The normal reactivity, the first condition in our enumeration, is at times suddenly transformed into the allergic state (the third condition); ulcerative and other late yaws lesions result from superinfection of monkeys with local yaws. In this condition the last nonreactive stage is reached gradually and at times very late.

No transformation of the second condition into the third or vice versa was ever observed in experimental yaws.

This recapitulation of our previous findings in experimental yaws was necessary to make intelligible the purpose and the results of the experiments herewith presented.

Experimental evidence has already been presented [9] that a high degree of immunity to yaws protects Philippine monkeys against cutaneous infection with syphilis. In the terms used in this discussion the state of complete nonreactivity reached through yaws infection applies likewise to cutaneous inoculation with treponemas of syphilis. Thus, the immunologic relationship between the dermatotropic treponema of yaws and the mesodermophilic treponema of syphilis has been experimentally demonstrated.

The present experiment shows that superinfection of yaws animals with syphilis, like superinfection with yaws, may cause exacerbation of a vanishing yaws lesion. Furthermore, superinfection with syphilis of yaws-immunized and yaws-immune monkeys may provoke a negative phase with regard to yaws. At the same time these experiments show that viable and virulent treponemas of yaws may remain in the skin of immunes for months at the place of inoculation without producing lesions.

This experiment, therefore, confirms and amplifies the experimental evidence already presented concerning the immunologic relation between yaws and syphilis.

[9] Philip. Journ. Sci. 35 (1928) 209.

CONCLUSIONS

1. There exists an immunologic relationship between yaws and syphilis with regard to the negative phase which is responsible for the occurrence of exacerbations and relapses in treponematoses.

2. The immunity following yaws vaccination in some instances is not as firmly established as the immunity following yaws infection with clinical manifestations.

3. Treponemas of yaws may survive for a considerable time in the skin of immunes to yaws, without producing a lesion.

ANALYSIS OF PHILIPPINE LUMBANG OIL

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Philippine lumbang (candlenut) oil is a drying oil which is used in making paints, varnishes, and similar products.[1] A preliminary investigation of lumbang oil was made by West and Montes,[2] who showed that it consists principally of a mixture of unsaturated glycerides (linolenic, linolic, and oleic). The mixed unsaturated acids, obtained from these glycerides, may be separated from each other by converting them into their bromo-derivatives[3] which can be separated by solvents. The bromo-derivatives can then be reduced again to the individual unsaturated acids. Since the mixed acids obtained from the glycerides of lumbang oil contain only a very small percentage of saturated acids and consist principally of the unsaturated acids linolenic, linolic, and oleic, lumbang oil serves as a good source of material for preparing these unsaturated acids, their addition products, and derivatives.[4]

In addition to the principal constituents of lumbang oil, Santiago and West[5] isolated from lumbang oil an essential oil of characteristic lumbang odor. They also prepared from lumbang oil four different linolic tetrabromides which apparently

[1] West, A. P., and W. H. Brown, Bull. P. I. Bur. Forestry **20** (1920) 121; West, A. P., and F. L. Smith, Bull. P. I. Bur. Forestry **24** (1923).

[2] Philip. Journ. Sci. 18 (1921) 619.

[3] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585.

[4] West, A. P., and L. Gonzaga, Philip. Journ. Sci. 23 (1923) 277.
West, A. P., and A. I. de Leon, Philip. Journ. Sci. 24 (1924) 123.
Imperial, G. A., and A. P. West, Philip. Journ. Sci. 31 (1926) 441.
Santiago, S., and A. P. West, Philip. Journ. Sci. 32 (1927) 41.
Smith, F. L., and A. P. West, Philip. Journ. Sci. 32 (1927) 297.
Oreta, A. T., and A. P. West, Philip. Journ. Sci. 33 (1927) 169.
Almoradie, P. R., and A. P. West, Philip. Journ. Sci. 33 (1927) 257.
Jovellanos, C. M., and A. P. West, Philip. Journ. Sci. 33 (1927) 349.
Santos, I., and A. P. West, Philip. Journ. Sci. 34 (1927) 199.
Vicente, M. L. A., and A. P. West, Philip. Journ. Sci. 36 (1928) 73.

[5] Philip. Journ. Sci. 32 (1927) 41.

are derivatives of four different linolic acids that occur naturally as glycerides in lumbang oil.

Recently we had occasion to prepare a new supply of lumbang oil. After successive treatments (warming, shaking, and filtering) with kieselguhr, suchar, and talcum powder, a sample of oil was obtained with only a slight yellow color and a very high degree of purity. With such a high-grade oil at our disposal it seemed desirable to make a complete analysis and determine the exact amount of all the constituents contained in the oil.

EXPERIMENTAL PROCEDURE

The lumbang oil used in this investigation was prepared (cold pressed) from seeds which were kindly presented to us by Dr. Nemesio Mendiola, of the College of Agriculture, University of the Philippines. The constants of this oil are given in Table 1.

TABLE 1.—*Constants of lumbang oil.*

Specific gravity $\frac{29^\circ \text{ C.}}{4^\circ \text{ C.}}$	0.9170
Refractive index $N\frac{30^\circ \text{ C.}}{D}$	1.4740
Saponification value	191.7
Iodine number (Wijs, 6 hours)	152.7
Unsaponifiable matter (per cent)	0.34
Oxyacids (per cent)	0.13
Free fatty acids as oleic (per cent)	0.05
Color:	
Red	0.1
Yellow	1.5

The oxyacids were determined by a modification of Fahrion's method.[6] The oil was saponified, the resulting soaps decomposed with dilute sulphuric acid, and the mixed acids extracted with ether. The ether was then removed by distilling and the acids treated with petroleum ether which precipitated the oxyacids and dissolved the unoxidized acids. After decanting off the petroleum ether solution the oxyacids were dissolved in ether, and the ether removed by distilling.

The color of the lumbang oil was determined by a Wesson model, cabinet type colorimeter made by the Emil Greiner Co.

[6] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats and Waxes 1 (1921) 593; West, A. P., and A. I. de Leon, Philip. Journ. Sci. 24 (1924) 134.

The essential oil of lumbang was determined by the method of Santiago and West.[7] This method consists in precipitating, as zinc soaps, the acids which occur as glycerides in the oil. The zinc soaps were then removed by filtering and the filtrate extracted with ether to obtain the lumbang essential oil which gave a yield of 0.30 per cent.

The saturated and unsaturated acids which occur as glycerides in lumbang oil were separated by the lead-salt-ether method.[8] The results are recorded in Table 2.

TABLE 2.—*Separation of saturated acids from the unsaturated acids in lumbang oil by the lead-salt-ether method.*

Experiment No.	Oil used.	Unsaturated acids.	Saturated acids.	Unsaturated acids.	Saturated acids.
	g.	*g.*	*g.*	*Per cent.*	*Per cent.*
1	8.9450	8.3628	0.1885	93.49	2.11
2	8.6753	8.1041	0.1895	93.42	2.18
Mean				93.46	2.15

As the mixed acids, which occur as glycerides in lumbang oil, contain only a small percentage of saturated acids no attempt was made to convert these saturated acids into their methyl esters, separate by distilling, and estimate the individual saturated acids.[9]

In the lead-salt-ether method of separation any oxidized acids which may be present as glycerides in the oil go with the saturated acids since the lead salts of oxidized acids are insoluble in ether. We tested this point by preparing the lead salts of oxidized acids from a sample of lumbang oil which had been blown for twenty hours and the lead salts were found to be insoluble in ether. The saturated acids (2.15 per cent, Table 2) as determined by the lead-salt method must therefore be corrected for the small amount of oxidized acids (0.13 per cent, Table 1) which is contained in the saturated acids. The corrected percentage of saturated acids would therefore be 2.15

[7] Philip. Journ. Sci. 32 (1927) 41.

[8] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 556; West, A. P., and Z. Montes, Philip. Journ. Sci. 18 (1921) 619.

[9] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 679.

minus 0.13, or 2.02 per cent. The glycerides corresponding to these acids would therefore be as follows:

	Per cent.
Saturated:	
Acids	2.02
Glycerides	2.10
Oxidized:	
Acids	0.13
Glycerides	0.14

The composition of the unsaturated acids separated from lumbang oil by the lead-salt-ether method was determined by means of the bromo-derivative method.[10] This consists in converting the unsaturated acids into their bromo-derivatives which are then separated by suitable solvents. The laboratory data for duplicate analyses are given in Tables 3 and 4.

TABLE 3.—*Determination of unsaturated acids of lumbang oil (bromo-derivative method). Analysis 1.*

	Grams.
Sample of unsaturated acids	3.4413
Hexabromide (ether-insoluble bromide)	0.7547
First crop of tetrabromide	0.0854
Second crop of tetrabromide	0.7259
Residue (dibromide and tetrabromide); bromine content, 45.57 per cent	5.0285
Dibromide in residue, 45.25 per cent	2.2754
Tetrabromide in residue, 54.75 per cent	2.7531
Total tetrabromide found	3.5644
Linolenic acid equivalent to hexabromide	0.2771
Linolic acid equivalent to tetrabromide	1.6652
Oleic acid equivalent to dibromide	1.4528

TABLE 4.—*Determination of unsaturated acids of lumbang oil (bromo-derivative method). Analysis 2.*

	Grams.
Sample of unsaturated acids	3.1967
Hexabromide (ether-insoluble bromide)	0.6798
First crop of tetrabromide	0.1227
Second crop of tetrabromide	0.5339
Residue (dibromide and tetrabromide); bromine content, 46.11 per cent	4.8134
Dibromide in residue, 42.10 per cent	2.0264
Tetrabromide in residue, 57.90 per cent	2.7870
Total tetrabromide found	3.4436
Linolenic acid equivalent to hexabromide	0.2496
Linolic acid equivalent to tetrabromide	1.6087
Oleic acid equivalent to dibromide	1.2938

[10] Lewkowitsch, J., Chemical Technology and Analysis of Oils, Fats, and Waxes 1 (1921) 585; West, A. P., and Z. Montes, Philip. Journ. Sci. 18 (1921) 619.

The bromine in the residue was determined by the method of Drogin and Rosanoff.[11] This consists in decomposing an alcoholic solution of the compound with sodium. Silver nitrate in excess is now added and the mixture filtered. The excess silver nitrate is then titrated with ammonium thiocyanate.

A summary of these duplicate analyses (Tables 3 and 4) is given in Table 5.

TABLE 5.—*Unsaturated acids of lumbang oil, summary of analyses 1 and 2.*

Acid.	Analysis.		Mean.
	1	2	
	Per cent.	*Per cent.*	*Per cent.*
Linolenic	8.05	7.81	7.93
Linolic	48.39	50.33	49.36
Oleic	42.22	40.47	41.35
Total	98.66	98.61	98.64

TABLE 6.—*Crystallized linolic tetrabromides and the corresponding linolic acids from 100 grams of mixed unsaturated lumbang acids.*

Name.	Linolic tetrabromide.	Linolic acid.
	Per cent.	*Per cent.*
Alpha	31.37	14.65
Beta	9.90	4.62
Delta	3.30	1.54
Total	----------	20.81

	Per cent.
Total linolic acids (Table 5)	49.36
Linolic acids (alpha, beta, and delta) (Table 6)	20.81
Gamma linolic acid	28.55

Experiments carried out by Santiago and West[12] showed that four different linolic tetrabromides (alpha, beta, delta, and gamma) could be obtained from lumbang oil. The results indicated that these tetrabromides are probably derivatives of four different linolic acids which occur naturally as glycerides in lumbang oil. In Table 6 is given the results of our determination of these individual tetrabromides and also the percentage of linolic acids corresponding to the tetrabromides. The

[11] Journ. Am. Chem. Soc. **38** (1916) 711.
[12] Philip. Journ. Sci. **32** (1927) 41.

calculations are based on 100 grams of mixed unsaturated acids. The alpha linolic tetrabromide was determined experimentally. As it is difficult to separate the beta and delta tetrabromides quantitatively we made only a partial separation and estimated the approximate composition of the mixture.

In Table 7 is given the composition of the mixed unsaturated acids of lumbang oil. There is also included the calculated percentages of glycerides in lumbang oil corresponding to the individual unsaturated acids.

The composition of lumbang oil as determined by our analysis is given in Table 8.

TABLE 7.—*Calculation of unsaturated acids, including the individual linolic acids, to the glycerides of lumbang oil.*

Acid.	Mixture of unsaturated acids.	Original oil.	Glycerides in original oil.
	Per cent.	*Per cent.*	*Per cent.*
Linolenic	7.93	7.41	7.74
Linolic:			
Alpha	14.65	13.69	14.30
Beta	4.62	4.32	4.51
Delta	1.54	1.44	1.50
Gamma	28.55	26.68	27.88
Oleic	41.35	38.65	40.39
Total	98.64	92.19	96.32

TABLE 8.—*Composition of Philippine lumbang oil.*

Constituent.	Per cent.
Essential oil	0.3
Unsaponifiable matter	0.3
Glycerides of:	
Saturated acids	2.1
Oxidized acids	0.1
Unsaturated acids:	
Linolenic	7.7
Linolic:	
Alpha	14.3
Beta	4.5
Delta	1.5
Gamma	27.9
Oleic	40.4
Total	99.1

As in a former investigation,[13] the data (Table 8) show that lumbang oil consists principally of the glycerides of linolenic, linolic, and oleic acids and contains only a very small percentage of saturated glycerides. The percentages of linolenic and linolic glycerides were found to be higher in this investigation than in the former one, while the percentage of oleic glyceride was less. The reason why the results given in this analysis are somewhat different from those recorded in the former investigation is probably due to differences in experimental procedure. Linolenic hexabromide is slightly soluble in ether so this precipitate should not be washed excessively as this would tend to give a low yield of hexabromide. Again the ether used for washing should be cooled previously in ice water as the hexabromide is less soluble in cold ether. In removing the petroleum ether from the residue of dibromide and tetrabromide the residue should not be heated too highly as some bromine may be volatilized. This would result in giving a somewhat high yield of dibromide and a low yield of tetrabromide when the composition of the mixture is calculated. The petroleum ether is best removed from the mixed bromides by evaporating before an electric fan. The residue, which usually contains some moisture, should be dissolved in ether, dehydrated with sodium sulphate and most of the ether removed by evaporating in an oven at 45° C. The remainder of the ether may then be eliminated by evaporating before an electric fan.

SUMMARY

The composition of lumbang oil including the individual unsaturated acids has been determined. The results indicate that the oil consists principally of the glycerides of linolenic, oleic, and various linolic acids.

[13] West, A. P., and Z. Montes, Philip. Journ. Sci. 18 (1921) 619.

THE ULTRA-VIOLET TRANSMISSION OF PHILIPPINE WINDOW SHELL [1]

By Wm. D. Fleming
Captain, Medical Corps, United States Army

ONE TEXT FIGURE

Lately much attention has been given to the ultra-violet region of the spectrum. In addition to purely chemical effects, the discovery of the activation of the antirachitic vitamin by ultra-violet focused attention on this form of radiation as a physiological agent. At present the popular craze for sun tan, over as great an area of body surface as the owner's leisure or the police will permit, is but an indication of how widespread is the belief in the therapeutic powers of sunlight.

As a result, much work has been done on transparent or translucent media, suitable for windows, which will transmit an appreciable amount of the ultra-violet present in sunlight, especially that comprising the "vital region" of the spectrum lying between the wave lengths 290 and 310 millimicrons.

Ordinary window glass, of the thickness usually required (3 millimeters or more), transmits less than 1 per cent at 310 millimicrons and none of the shorter wave lengths. At the other extreme is transparent fused quartz with a transmission of about 90 per cent in the ultra-violet spectrum. However, the very high cost of this material restricts its use. Between these two materials there have appeared special glasses which transmit between 25 and 60 per cent of the vital ultra-violet. These special glasses have been found to decrease in transmission to some extent when first exposed to ultra-violet but then become stabilized and suffer no further deterioration. Their use is becoming widespread in the United States and in England.

This use suggested to the writer the question of the transmission for ultra-violet of the shell widely used in the Philippine Islands in place of window glass. Several interesting angles to

[1] From the Radiation Measurements Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

this question are apparent; namely, the connection with the low incidence of rickets in the Philippine Islands, the advantage the shell might possess in the opposite direction in affording a screen from injurious amounts of ultra-violet, and the possibility of the shell as an article of export in competition with the special glasses mentioned.

Maj. J. S. Simmons, Medical Corps, United States Army, president of the United States Army Medical Department Research Board, Manila, Philippine Islands, very kindly sent me two specimens of the window shell and an extract of the description in the Philippine Journal of Science. Dr. Pablo I. de Jesus, of the Rockefeller Foundation, also most kindly secured a number of specimens of shells for me and a description. My sincere thanks are extended to both these gentlemen for this valuable aid.

DESCRIPTION OF THE PHILIPPINE WINDOW SHELL

For readers outside of the Philippine Islands, the following is extracted from the excellent article on the Philippine window shell by Alvin Seale.[2]

In the majority of windows in the city of Manila, the pane is of shell instead of glass. The shell used for this purpose is called *kapas* or window-shell (*Placuna placenta* Linn.).

This shell is thin and flat with a rounded outline, and resembles somewhat a very large wafer. The entire shell including the animal is about 1 centimeter in thickness by 14 centimeters in diameter. The left side (valve) of the shell is slightly convex, the right side is flat. The right side is easily transformed into a windowpane simply by squaring off the edges with a big pair of scissors or a crude machine such as is used for cutting plug tobacco. The shells are then framed and are ready for use. The size of the shell most in demand will square 7.5 centimeters, although those that square 6.5 centimeters are also much used. The opinion prevailing among the general public regarding window shell is that it is a slab of shell split off from some larger shell. This, needless to say, is entirely erroneous, as the window-shell is used in the natural condition, the two halves being torn apart and the edges merely trimmed. The left side of the shell is convex and hence is in but small demand. Windows made of these shells are translucent, admitting a soft light, very grateful to the eyes in a tropical country.

These windows of shell last for generations. Some of the old churches in Manila have shell windows which have been exposed to the weather for over a hundred years and which are still serviceable. Shell windows are easily repaired as a new shell is easily sprung into place when one becomes broken or worn.

[2] Philip. Journ. Sci. § D 6 (1911) 296 et seq.

Shell windows are made of narrow strips of wood usually 13 to 18 millimeters wide and 13 millimeters thick, or they may be any size desired. These strips are grooved on two sides and notched every 6.0 or 7.5 centimeters as the case may be, to receive the cross stick which also is notched; thus a solid square frame is formed for each shell. After these are put together the entire square is set in a solid frame to fit the window or door.

METHOD AND APPARATUS FOR DETERMINING TRANSMISSION

Transmission was determined by a photographic method with a quartz spectrograph. Compensation for the scatter of the light due to the translucence of the shell was effected by means of an integrating sphere.

Because of this translucence, light is transmitted by the shell, not as a regular beam, but is scattered in all directions upon emergence. Since we have no data on the degree of this scatter, or how it may vary with wave length, this at once precluded any method for determining transmission in which light is passed through the shell and hence directly to some form of receptor of radiation such as a thermopile radiometer, photographic plate, or photoelectric cell. To annul the effect of this scatter recourse was had to a method similar to the use of the integrating sphere in determining the total light flux of a source.

A sphere was made up of two hemispherical shells, each 6 inches in diameter (sand-bath shells). Two holes of $\frac{3}{4}$-inch diameter were bored in one of these hemispheres, each hole being 45° from the pole and in the same plane. A small screen of such size that it just occluded all direct light from one hole to the other was fixed inside on a post at the pole of this hemisphere. The inner surface of both hemispheres (including the screen mentioned) was then smoked with burning magnesium ribbon. This, while tedious in application, gave a matte white surface of good reflecting power. The two hemispheres were then bound together with tape to form an integrating sphere 6 inches in diameter. One of the holes was placed in front of the spectrograph slit. The light was thrown into the other hole, immediately before which the shell was placed.

The direct component of the light entering the sphere was cut off from the exit hole by the screen. Hence the only light emerging from the sphere was that which had undergone multiple reflection within the sphere. This multiple reflection integrated the scattered light transmitted through the shell placed in the path of the entering light in the same manner that a similar sphere integrates the various directional components of a light source placed within it.

After trial of various light sources a small, inclosed, water-cooled mercury arc in quartz was used. Although relatively weak, this had two important advantages. The light was completely screened except for a small aperture, which greatly simplified the problem of excluding stray light from the spectrograph. Of greater importance was the filtering out of the longer wave lengths by the water. In a trial of a more powerful mercury arc, air cooled, it was found that the heat from the arc burned the shell to a pearl-like opacity in the time required for the longer exposures. The lamp circuit included adjustable resistances and a voltmeter. The voltage across the lamp was held constant at 57.5 volts direct current.

The exit hole of the sphere was placed 20 centimeters in front of the slit of a large Hilger quartz spectrograph. The lamp was placed immediately in front of the other hole of the sphere, leaving only sufficient space to insert the shell (in contact with the sphere) and a black metal shutter. Stray light, such as was reflected from the outside of the sphere and shell, was carefully screened off from the spectrograph. The system was then lined up to secure maximum brightness on the spectrograph screen.

With the apparatus set up in this manner the transmission was determined as follows. The light was occluded by the shutter in front of the sphere and a fast emulsion plate inserted in the spectrograph. The wave-length scale was first printed on one edge of the plate. Immediately under this the spectrum of the lamp without the shell was photographed, using a base exposure of three minutes. The shell was then placed in front of the sphere and the spectrum photographed with an exposure of twenty times the base exposure. In like manner the spectrum through the shell was photographed with exposures of 10, 6.66, 5, 4, 3.33, 2.5, 1.66, and 1.25 times the base exposure, a photograph (with base exposure of three minutes) of the spectrum of the light without the shell being made between each pair of these other exposures for purposes of comparison. Finally, the wave-length scale was again printed on the edge of the plate. The plate was then developed, fixed, washed, and dried.

On examination of the dried plate a region of the spectrum of the 20-times exposure was found which matched in density the basic 3-minute exposure. At the wave length of this region of match, the transmission was therefore 5 per cent. In like

manner regions of density matching that of the base exposure were found for each of the other exposures made through the shell, giving the wave length of the transmission corresponding to the ration of each exposure to the base exposure (5, 10, 15, 20, 25, 30, 40, 60, and 80 per cent transmission). The matching of these densities was done independently by two observers as shown in the table. Since the comparison with the base exposure was made in each case between two spectra photographed immediately before or after each other and immediately adjacent on the plate, irregularities in the emulsion of the plate, in the process of development, and in the light were compensated.

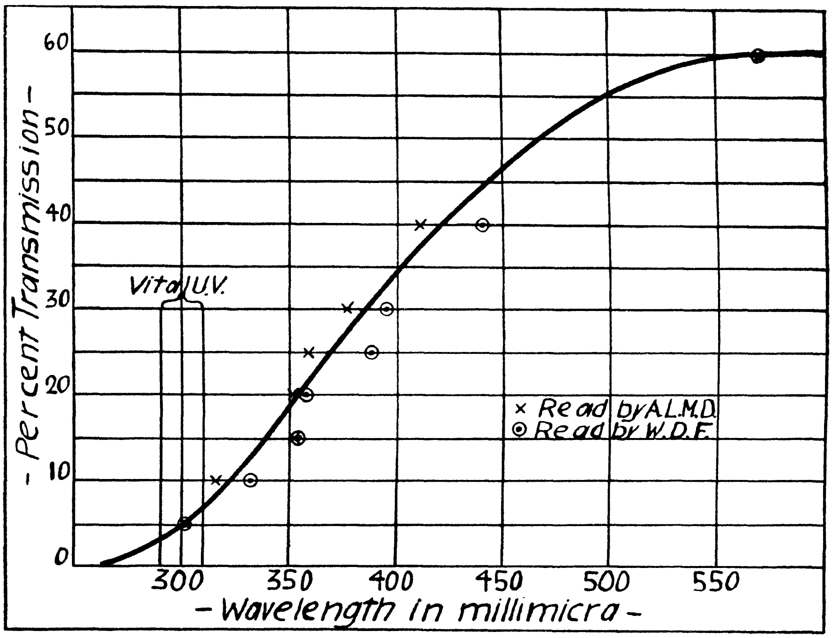

FIG. 1. Transmission of ultra-violet by Philippine window shell.

RESULTS

The shell used was of an average thickness over the area examined of 1.3 millimeters. The percentage of transmission at various wave lengths is shown in Table 1 and in the graph (fig. 1).

TABLE 1.—*Percentage of transmission of ultra-violet by Philippine window shell.*

Transmission.	Wave length (millimicrons).		
	As read by—		As plotted.
	A. L. M. D.	W. D. F.	
Per cent.			
5	302	302	302
10	315	332	324
15	352	353	340
20	351	358	354
25	358	388	370
30	377	395	385
40	410	440	420
60	570	570	570
80	([a])	([a])	----------

[a] No match.

From these data it is evident that the transmission of the shell in the vital region of the ultra-violet is only 3 to 6 per cent.

It would appear from this that in so far as light may be a factor in the low incidence of rickets in the Philippine Islands it is the light received direct and not that through windows of the window shell. This is consistent with the outdoor life induced by the climate of the Islands. The ultra-violet transmission is not sufficient to warrant export of the shell primarily as a competitor of the various special glasses now on the market in the United States. On the other hand this low transmission may be of distinct advantage in its use in any locality where relief from the glare of the sun is sought.

SUMMARY

1. A method of measuring the transmission of a translucent material is described. The integrating-sphere effect was used to compensate for the scatter of the transmitted light, this scatter preventing the use of the ordinary methods of obtaining transmission.

2. The transmission of Philippine window shell for the vital ultra-violet of 290 to 310 millimicrons wave length was found to be from 3 to 6 per cent.

ACKNOWLEDGEMENT

The writer desires to acknowledge the help received from the personnel of the Radiation Measurements Laboratory of Massachusetts Institute of Technology; Prof. D. C. Stockbarger, Mr. A. L. M. Dingee, Mr. L. B. Johnson, and Mr. Laurence Burns. Without their aid and counsel in planning the work and help in its execution but little would have been done.

Cambridge, Mass., August 23, 1929.

ILLUSTRATION

TEXT FIG. 1. Transmission of ultra-violet by Philippine window shell.

EFFECT OF INTRAVENOUS INJECTIONS OF ETHYL ESTERS OF CHAULMOOGRA OIL ON THE PULMONARY TISSUES OF THE RABBIT [1]

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TWO PLATES

The intravenous administration of the ethyl esters of chaulmoogra and hydnocarpus oils has been employed in the treatment of leprosy for the purpose of avoiding the painful and incapacitating local reactions which frequently follow intramuscular injection. Rogers(1) and Harper(2) have reported their experience with the intravenous method of treatment and are of the opinion that it can be used with safety to the patient. Harper(3) has given plain chaulmoogra oil intravenously and has detected no harmful effects after several thousand injections. In a paper dealing with the treatment of pulmonary tuberculosis with the chaulmoogra oil esters, Lissner(4) has reported observations on twenty-five cases treated for periods ranging from three months to one year. Intravenous injection of 1 cubic centimeter of the drug was followed by a paroxysm of coughing and an increase in the volume of sputum. The lungs showed an increase in the area of infiltration which persisted from two to three days following injection and then gradually decreased in size. There was no aggravation of bleeding in the hæmorrhagic cases. Some of the patients complained of precordial distress and dyspnœa immediately following treatment, and one patient had vertigo, a tendency to faint, and inability to walk five minutes after intravenous administration of 1 cubic centimeter of the esters. After four to eight injections, there was an increase in pulse rate, the cardiac impulse was more forcible, and the first heart sound became booming in character. These signs were attributed to a direct cumulative action on the heart.

Walker, McArthur, and Sweeney(5) in their studies on the chemotherapeutic action of the ethyl esters of chaulmoogra oil,

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found that 1 cubic centimeter of the drug produced early death when given intravenously to rabbits. They thought this was probably due both to the rapid absorption of the drug and to the mechanical action of pulmonary emboli. Repeated injections of 0.0715 cubic centimeter of the drug per kilogram of body weight, a dose calculated on the basis of the maximal intravenous dose used in man, was found to produce in rabbits marked hypertrophy of the lungs. In similar experiments, Read(6) reported the lethal effect on rabbits of 0.5 cubic centimeter of ethyl hydnocarpate per kilogram of body weight. He questioned, however, if death could be ascribed to the pulmonary effects of the drug which he considered to be less important than its central depressant action.

We have resorted to intravenous administration of from 0.5 to 2.5 cubic centimeters of the ethyl esters of chaulmoogra and hydnocarpus oils in several cases where intramuscular injection has caused so much local inflammatory infiltration of the tissues as to interfere with the patient's comfort and activities. Invariably severe paroxysms of coughing followed the injections, especially after the patient had risen to his feet. No other reaction, clinically demonstrable, has been observed which could be attributed to embolism. One patient to whom a total of 112 cubic centimeters of the esters in single doses of 0.25 to 2.5 cubic centimeters had been given intravenously at three- to seven-day intervals extending over a period of three hundred forty-seven days, did not show any röntgenologic evidence of changes in the lungs at the end of this time.

In consequence of the foregoing clinical and experimental observations we have formed the opinion that the intravenous administration of the esters of chaulmoogra oil is not without danger to the patient. It is to be assumed that massive doses of any oily substance, such as the ethyl esters, introduced directly into the circulation, would result in severe or fatal reactions consequent on embolism of the pulmonary blood vessels. Whether the repeated injection of small amounts of such substances would induce appreciable changes in the pulmonary tissues of such a character as to interfere with their normal function is a matter of speculation.

It is the purpose of this paper to report experiments in which a study has been made of the pathological changes in the lungs of rabbits following intravenous injection of the ethyl esters of chaulmoogra oil. The first part of the report deals with the

effect of lethal doses on the lungs of rabbits and the second part, with the effect of serial administration of quantities of the drug comparable to those used therapeutically in man.

I. EFFECT OF TOXIC DOSES OF THE ETHYL ESTERS OF CHAULMOOGRA OIL ON THE PULMONARY TISSUES OF RABBITS

EXPERIMENTAL

Five rabbits weighing from 1,000 to 1,400 grams were used for the experiment. Three of these were injected with 0.2 cubic centimeter and two with 0.3 cubic centimeter of the ethyl esters of chaulmoogra oil which had been sterilized in the autoclave for forty-five minutes under 15 pounds steam pressure. Injection was made into the marginal ear vein. The ear was transilluminated during the procedure to insure the needle being in the lumen of the vein, and to reveal any local vascular response to the presence of the drug.

One animal was killed by a sharp blow on the neck one hour following injection. The remaining animals were allowed to survive as long as they would.

As soon after death as practicable an autopsy was performed; the viscera were removed and fixed in 10 per cent formalin solution. Frozen sections of both fresh and fixed tissues were stained with Sudan III for studying the localization of the ethyl esters in the lungs.

Reaction at site of injection.—Immediately upon contact with the blood the esters divided into minute globules of about the diameter of the blood vessel. No local vasomotor reaction was observed in any of the animals of this or subsequent experiments. Local inflammation with necrosis occurred at the site of injection in several rabbits, but in each instance this was preceded by extravasation of the injected substance. In our opinion the swelling and necrosis was due to the irritating action of the drug on the extravascular tissue, and not to peripheral vascular constriction as has been suggested by Ohara.(7)

RESULTS

Examination of the lungs of the rabbit that was killed an hour following injection showed an extensive œdema of the lobes of the right lung in which most of the material injected had localized (Plate 1, fig. 1). There were many well-defined hæmorrhagic areas on the surface of the lung, which on section

were found to be at the sites of infarcts. The capillaries and arterioles in these areas were filled with lipoid material, which had also infiltrated the perivascular alveolar tissue.

The other four animals died one, three, five, and fourteen days after injection, respectively. Since the pathological changes in all of these were of a similar nature, only the gross and microscopic description of the pulmonary tissues of the rabbit that died three days following an injection of 0.3 cubic centimeter of the ethyl esters is recorded in detail.

The pleural cavities contained a small amount of cloudy serum at their dependent portions, but generally they had been obliterated by fresh adhesions between the visceral and parietal pleuræ. The lungs were intensely inflamed throughout and a large part of each lobe was firmly consolidated. Scattered over the surface were large grayish yellow areas of firmer consistency than the intervening tissue which had a dark hæmorrhagic appearance.

The pleura over the grayish yellow areas was covered with an inflammatory cellular exudate bridging the pleura and parenchyma of the lung. There were many large and well-defined abscesses in the lung substance (Plate 1, fig. 2). At the margins of these were dense inflammatory zones beyond which there was marked œdema of the alveolar walls with seropurulent exudate in the air sacs. Many macrophages filled with a brown-yellow pigment were present in the interstitial tissues and in the alveoli. The capillaries were engorged with fibrin and with red and white blood cells, most of which were polymorphonuclears. There was extensive inflammation of the bronchioles.

Sections stained with Sudan III showed a diffuse fatty infiltration with many well-defined fat emboli both in the capillaries and in the large blood vessels (Plate 2, fig. 1). The macrophages were loaded with a fat-staining substance. Fat globules were found in the alveolar walls and in the alveoli.

II. EFFECT OF SERIAL ADMINISTRATION OF THERAPEUTIC DOSES OF ETHYL ESTERS OF CHAULMOOGRA OIL ON THE PULMONARY TISSUES

In view of the extensive damage to the lungs of large doses of the ethyl esters it seemed not unlikely that the serial administration of therapeutic doses as used in man might induce similar pathologic changes in the pulmonary tissues. In the following experiments rabbits were injected intravenously with doses of

the ethyl esters corresponding to those usually given intravenously to man in the treatment of leprosy. The maximal single dose for an adult human being is calculated on the basis of 0.04 cubic centimeter per kilogram of body weight.

EXPERIMENTAL

Eleven rabbits ranging from 1,120 to 2,410 grams in weight were injected through the marginal ear vein with 0.03 to 0.05 cubic centimeter of sterilized ethyl esters of chaulmoogra oil. Injections were given at three-day intervals throughout the period of the experiment or as long as the animal survived. With the exception of two animals, all died during the course of the series of injections, presumably from the effects of the chaulmoogra oil. Two rabbits survived 119 and 140 days, respectively. They were then killed by a blow on the neck, an autopsy was performed, and their lungs were fixed in a 10 per cent solution of formalin.

Of the nine animals dying during the course of treatment the earliest death occurred seven days after the first injection when the rabbit had received a total of 0.1 cubic centimeter of the ethyl esters, and the latest death occurred 200 days after the experiment was commenced. This animal had received at the time of death a total of 2.85 cubic centimeters of the drug. Autopsies were performed as soon as possible, not later than fourteen hours after death.

RESULTS

Table 1 shows the duration of treatment and the total quantity of the ethyl esters each animal received. The pathological changes induced were similar in all the rabbits, differing only in degree as determined by the quantity of ethyl esters the animal had received during the experiment.

When the rabbit had been under treatment for one hundred days or more there was an appreciable increase in size of the lungs. Their color was grayish yellow. The entire lung substance was firm and there were circumscribed areas of marked induration. On section the cut surface had a dense fibrous appearance.

On microscopic examination there was diffuse and extensive fibrous connective-tissue proliferation of the alveolar walls. Fibrosis was so marked in many places as to obliterate completely all evidence of normal alveolar structure of the organ. This

gave the section the appearance of a fibrous neoplasm (Plate 2, fig. 2). In these areas many of the remaining alveoli were considerably dilated and uniformly lined with cuboidal epithelium. The nuclei of the cuboidal cells were large and oval and stained deeply with hæmatoxylin. These alveoli contained either a small amount only of exudate or none. Alveoli which retained their normal platelike epithelium contained a large amount of seropurulent exudate. There were many fresh hæmorrhagic infarcts in the less-fibrotic portions of the lung.

TABLE 1.—*Summary of treatment of rabbits with therapeutic doses of the ethyl esters of chaulmoogra oil.*

Rabbit.			Treatment.		Ethyl esters of chaulmoogra oil administered.		Result.
No.	Weight.						
	Initial.	Terminal.	Duration.	Interval.	Maximal single dose.	Total.	
	g.	*g.*	*Days.*	*Days.*	*cc.*	*cc.*	
1	2,410	2,210	106	3	0.05	1.55	Died.
2	1,540	1,100	60	3	0.05	0.83	Do.
3	1,500	1,120	21	3	0.05	0.23	Do.
4	1,610	1,710	113	3	0.05	1.48	Do.
5	1,170	1,380	200	3	0.05	2.85	Do.
6	1,410	2,150	127	3	0.05	1.8	Do.
7	1,670	1,650	113	3	0.05	1.6	Do.
8	1,800	1,990	119	3	0.05	1.65	Living.
9	1,210	1,250	136	3	0.05	1.90	Died.
10	1,120	760	7	3	0.05	0.10	Do.
11	1,800	1,770	140	3	0.05	2.0	Living.

In areas where the fibrosis was less extensive the alveolar walls were œdematous and infiltrated with lymphocytes, polymorphonuclears, and fat-containing macrophages. Tubercle-like or giant-cell formations were not observed in any of the sections.

Many of the bronchioles were filled with an exudate consisting of necrotic alveolar cells, leucocytes, and macrophages. There was marked peribronchial lymphocytic infiltration.

In localized areas the pleuræ were covered with a thin layer of organizing exudate and at the bases in several animals there were dense fibrous adhesions.

Sections stained with Sudan III showed the fibrous connective tissue to be heavily infiltrated with minute oil globules some of which were free in the tissues, while others had been engulfed

by the large phagocytic cells. The oily substance was also present in the alveolar exudate and in the phagocytic cells it contained.

COMMENT

Any explanation of the toxic action of chaulmoogra oil esters when introduced directly into the circulation must take into account the pulmonary lesions induced by the drug as one, if not the chief, cause of death. From the observations we have made it seems that the most important single factor underlying the pathological changes in the lungs is the mechanical blocking of the smaller blood vessels by the esters. In an animal examined soon after administration of the drug there was marked pulmonary œdema and multiple and extensive infarction. Animals surviving the early reaction afforded opportunity for studying the subsequent course of the pulmonary lesions. The most conspicuous change in these was massive necrosis and abscess formation which involved most of the lung tissue.

Although the doses given to the animals used in the first experiment are proportionally ten times the therapeutic intravenous dose for man, they are of the same relative size as those used for intramuscular injection in clinical cases. It would seem, therefore, that the accidental injection of the ethyl esters into a blood vessel during the treatment of a patient might easily result disastrously from extensive pulmonary embolism.

Mobilization of large numbers of macrophages is an early and conspicuous reaction of the tissues to the presence of the chaulmoogra oil esters. Phagocytosis of the ethyl esters occurred in and around the alveolar capillaries, after which some of the fat-laden cells migrated into the alveolar air sacs.

Serial administration of therapeutic doses of the drug stimulated a diffuse and extensive fibrosis of the alveolar connective tissue, obliterating in large areas most of the parenchymal tissue. Many of the alveoli which were not destroyed showed a reversion of the respiratory epithelial cells to a large cuboidal form. The air spaces thus affected contained little or no exudate. This alteration of alveolar structure can best be explained on the basis of an induced atelectasis, the result of extensive fibrosis and immobilization of the lung substance. Gradual occlusion of the alveolar ducts may have served as an additional factor in producing this atelectatic condition.

Whether or not identical or similar pathological changes can be produced in the lungs of man by intravenous injection of cor-

responding amounts of the ethyl esters is problematic. In this respect it is of interest that Pinkerton,(8) in a study of six cases of oil aspiration in infants, has observed fibrosis of the alveolar walls and changes in the alveolar epithelium almost identical to that we have described in the animals of these experiments.

SUMMARY

When the ethyl esters of chaulmoogra oil were injected intravenously into rabbits in single doses of 0.2 and 0.3 cubic centimeter per kilogram of body weight, they produced, by embolic obstruction, extensive pulmonary infarcts with subsequent abscess formation, resulting in the death of the animal.

The serial administration of therapeutic doses of the drug comparable to those given intravenously to man in the treatment of leprosy produced generalized pulmonary fibrosis with wide-spread destruction of parenchymal tissue in the rabbit.

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ILLUSTRATIONS

PLATE 1

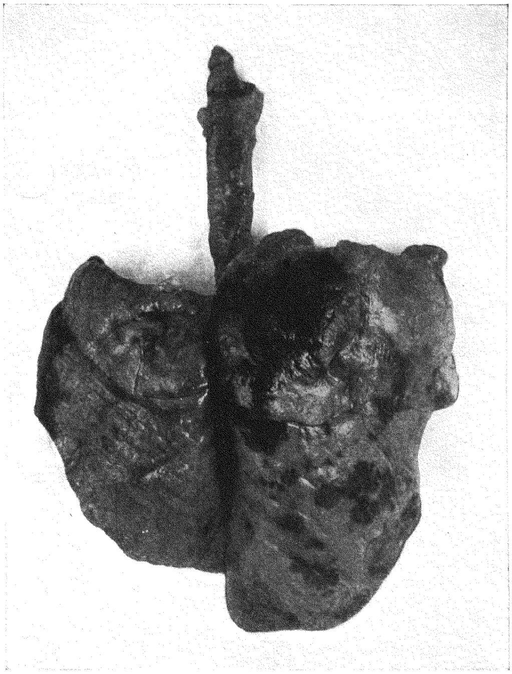
FIG. 1. Hæmorrhagic infarcts and œdema of rabbit's lung following intravenous injection of 0.2 cubic centimeter of ethyl esters of chaulmoogra oil.

2. Pulmonary infarcts in a rabbit with necrosis of tissues after intravenous injection of 0.3 cubic centimeter of ethyl esters of chaulmoogra oil.

PLATE 2

FIG. 1. Sudan III stain showing occlusion of a rabbit's pulmonary blood vessels with ethyl esters of chaulmoogra oil.

2. Pulmonary fibrosis in a rabbit following serial intravenous injections of therapeutic doses (0.05 cubic centimeter) of the ethyl esters of chaulmoogra oil over a period of one hundred thirteen days. Atelectatic alveoli with cuboidal epithelium. Fresh hæmorrhagic infarct at the right side of the section.



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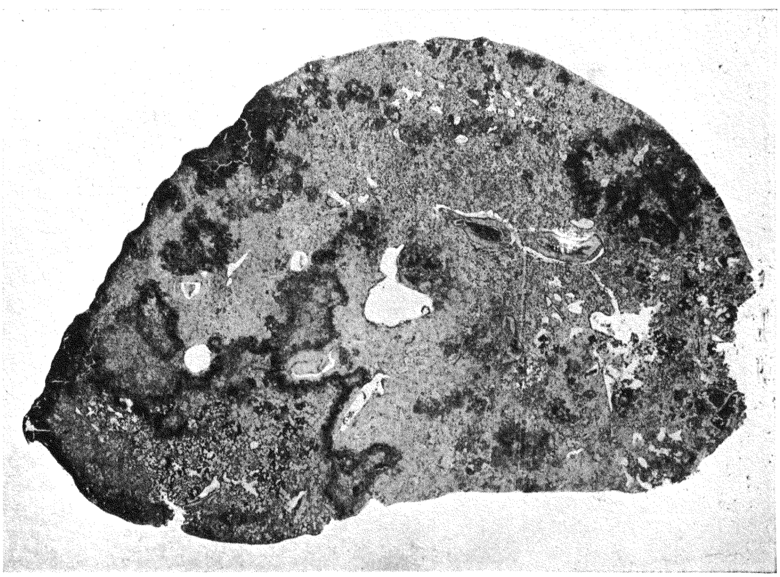

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PLATE 1.

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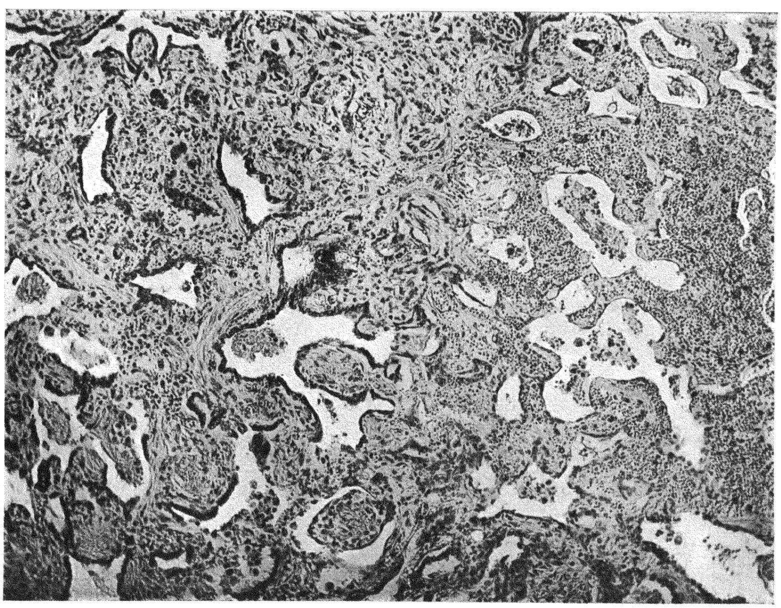

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PLATE 2.

COCCIDIOSIS IN ANOPHELES MOSQUITOES

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TWO PLATES

I failed to find in available literature any account of coccidial infection of mosquitoes. Anopheline infections with these parasites were noticed during the dry season of 1928, and in June, 1929. They were found in adults of all the common species of *Anopheles* from the Novaliches water project and the San Francisco malaria control areas, Rizal Province, Luzon, to the extent of about 1 to 2 per cent of each species dissected.

I was unacquainted with *Coccidium* and at first took the parasites for worm eggs. Dr. S. L. Brug, director of the Government Medical Laboratories in Weltevreden, Java, to whom I showed paraffin sections of parasitized mosquitoes, doubted their helminthic origin and advised me to consult Dr. R. Kudo's work on the parasites of mosquitoes. Kudo's studies, however, were, as far as I can determine, on *Microsporidia*.

Either two species of the parasite or two stages of the same parasite were observed. In 1928, only brownish yellow oöcysts were seen, but in 1929 some of the infected mosquitoes carried the brownish yellow, others a colorless variety, and a few a mixture of the two.

The brownish yellow oöcysts are generally oval with one pole slightly narrower or more pointed than the other; the largest measure 66 μ by 37 μ and the smallest, 31 μ by 25 μ (average, of ten oöcysts measured at random, 44.8 μ by 29 μ); they are of about the size, shape, and color of *Trichuris* ova (minus the knobs) and have the general appearance of small abnormal *Ascaris* eggs. The double-walled shell is thick, and the outer surface is coarsely rough with longitudinal ridges. The contents are not clearly visible in fresh preparations. The oöcysts give the impression of a coiled larva within each of them, when examined under a low power (2/3) objective (Plate 1, fig. 1). In stained paraffin sections of the mosquito, cross-sections of oöcysts are generally spherical with from eight to eleven rounded knobs corresponding to the ridges on the shell. A few of the sectioned oöcysts are without such knobs. The uncut oöcysts

do not take the stain, but their undifferentiated granular contents can be more clearly seen than in fresh preparations. The contents of sectioned oöcysts invariably take the stain. The shell, in longitudinally cut oöcysts, usually shows a slight flattening at the narrower pole like *Distomum* ova. In one sectioned mosquito many of the oöcysts are crescentic and the others are oval. Alcoholic fixation might have caused the distortion.

The colorless variety of oöcyst is similar in shape but on the average slightly smaller than the yellow one, and apparently with less rigid shell as evidenced by distorted forms. The largest is 58 μ by 31 μ, and the smallest 25 μ by 24 μ; average of ten oöcysts measured at random, 37.8 μ by 26.7 μ. The outer wall of the shell is smooth, thick, and highly refractile; the inner wall is thin. The undifferentiated granular contents either fill the shell completely or are retracted at one or both poles, similar to the unsegmented ova of the hookworm, although much smaller (Plate 1, fig. 2).

Distribution of the parasites in the mosquito.—Of the many routine larva examinations, in only one (*A. tessellatus* Theobald, from Laguna Province) was infection noticed (Plate 2, fig. 3). The oöcysts are found everywhere in the body, but most numerous in the thorax and first three abdominal segments.[1] In the heavily infected adult mosquitoes the oöcysts are found in the body cavity, coxæ, thorax, adipose tissue, around the brain, and in the labium (Plate 2, fig. 4). The cavity of the mid-gut, the brain substance, and the eggs are free from parasites, although the last may be completely and thickly covered with them. In lighter infections the oöcysts are mostly confined to the abdominal cavity. The mucosa of the stomach shows no apparent abnormality. Parasitized insects kept in the laboratory refrigerator (23 to 25° C.) lived as long as the noninfected ones.

Nothing is known about the life cycle and developmental forms. Oöcysts of the two varieties from different mosquitoes, which were kept in a moist chamber at 37° C. for weeks and at room temperature (20 to 30° C.) for as long as three months, showed no notable change in them except possibly a grouping of part of the granular contents into larger and more refractile globules.

[1] Since the transfer of the laboratory to Tungkong Manga, Bulacan Province, I found coccidial infection of *A. philippinensis* not only prevalent but so intense as to cause their death.

ILLUSTRATIONS

[Microphotographs by the Bureau of Science.]

PLATE 1

FIG. 1. Brownish yellow *Coccidium* oöcysts from the body cavity of *Anopheles minimus* Theobald; fresh preparation. × 350.

2. Colorless *Coccidium* oöcysts from *Anopheles vagus* Donitz. × 350.

PLATE 2

FIG. 3. *Coccidium* infected larva of *Anopheles tessellatus* Theobald. × 190.

4. Paraffin section of *Anopheles vagus*, showing heavy *Coccidium* infection. × 190.

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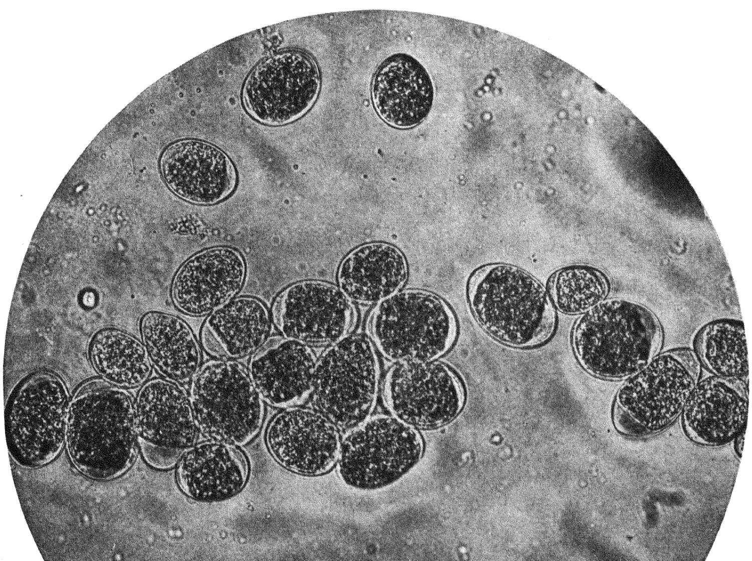

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PLATE 1.

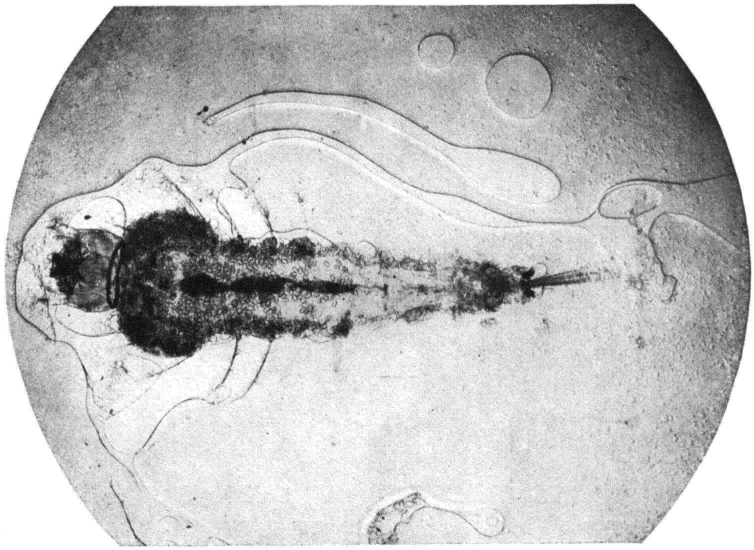

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PLATE 2.

PHLEBOTOMUS MANGANUS, A NEW SAND FLY FROM THE PHILIPPINES[1]

By C. MANALANG

Of the Philippine Health Service, Manila

ONE TEXT FIGURE

On the day the laboratory work was transferred from Manila to the field laboratory at Tungkong Manga, Bulacan (August 28, 1929), I noticed sand flies hopping out of a tree hole some 100 meters from the building and 3 meters from a stream. The hole was just above the ground, a sort of crevice at the base of the trunk, black inside as if burnt, with pieces of black honeycombed material, probably an abandoned ant house. About fifty flies were collected from the hole, including a few on the bark outside. All had recumbent hairs on the dorsum of the abdomen, and apparently belonged to one species, but the wings of some were slightly wider and appeared more voluminous than those of others. Potash preparations and isolation of buccopharyngeal armatures showed the narrow-winged ones to be *P. nicnic* Banks,[2] the only recumbent-haired sand fly reported from the Philippines, while the others belong to an undescribed species, for which I propose the name *Phlebotomus manganus*.

PHLEBOTOMUS MANGANUS sp. nov.

DESCRIPTION

A medium-sized fly; male yellowish brown, female dark yellowish gray, wings golden and irridescent, legs silvery by transmitted light; clypeus, dorsum of thorax, and first abdominal segment covered with erect hairs; hairs on the dorsum of all the other abdominal segments recumbent, on the ventral surface semirecumbent; antennæ and hind legs long; wings voluminous and clothed with grayish brown hairs; eyes somewhat pear-shaped and black; halteres dark brown.

[1] From the field laboratory of the division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan.

[2] Philip. Journ. Sci. 14 (1919) 163.

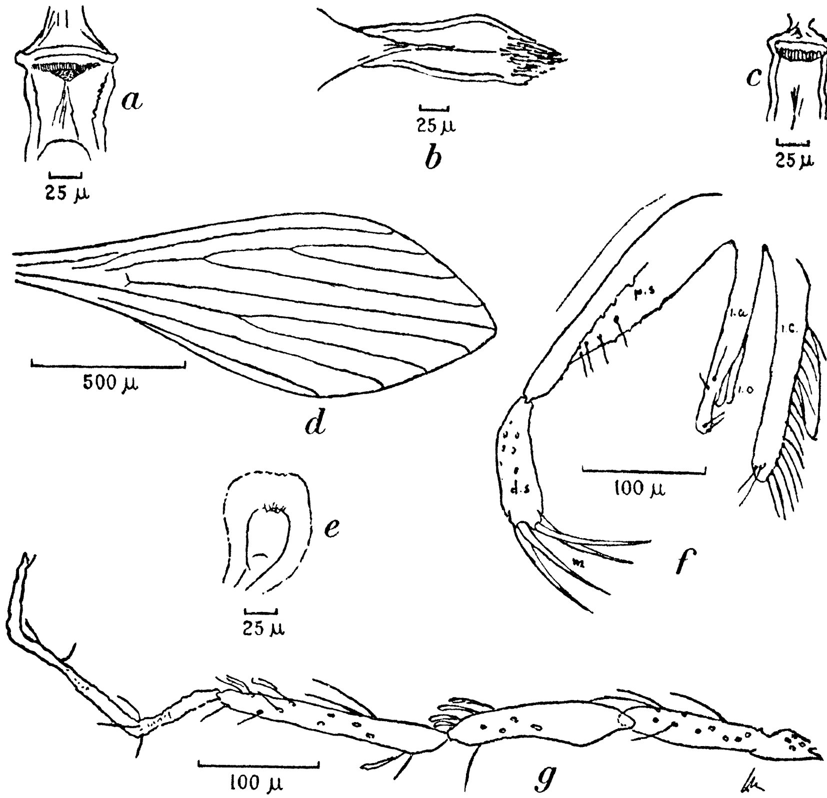

FIG. 1. *Phlebotomus manganus* sp. nov., drawn from potash preparations, except the spermatheca; *a*, buccal armature, female; *b*, pharyngeal bulb, female; *c*, buccal armature, male; *d*, wing, female; *e*, spermatheca (dissected fresh, mounted in 5 per cent formalin); *f*, genitalia, male (*ps*, proximal segment; *ds*, distal segment; *m*, macrochætæ; *ia*, intermediate appendage; *io*, intromittent organ; *ic*, inferior clasper); *g*, palp, female.

FEMALE

Palps (*fig. 1, g*).—Covered with hairs and scales. First segment with few hairs on lateral surface and about one-third the length of second segment; the latter shorter than either third or fourth segment; fourth segment longer than third; fifth segment shorter than the combined lengths of third and fourth segments except in female 3 (Table 2) in which it is longer. Total length of palp, 0.79 to 0.93 millimeter.

Antennæ.—Third segment more than twice the length of fourth segment. Geniculate spines present. Total length of antenna, 1.87 to 1.90 millimeters.

Buccopharynx (*fig. 1, a and b*).—Buccal armature with triangular, very dark, pigmented area with its base directed backward. Teeth numerous, extremely fine, and close together in one row. Pharyngeal bulb with thick wall; teeth in its

œsophageal end many, long, pointing backward, with conical bases, slender body, and filamentous extremities and only clearly visible under oil immersion.

Thorax.—No scales on the pleuræ. Integument pale yellow laterally and dark brown on the dorsum.

Abdomen.—Integument dark brown; length, 1.20 to 1.25 millimeters. Total length of body, including clypeus and superior clasper, 2.27 to 2.30 millimeters.

Wings (fig. 1, d).—Third longitudinal vein divides the wing into two equal parts; curvature of anterior and posterior borders the same. Upper branch of second longitudinal vein one and two-thirds times the distance between the two forks; δ one and one-sixth times the distance between the two forks. Measurements of important wing veins of one female are as follows: α, 0.500 millimeter; β, 0.300; γ, 0.300; δ, 0.350; ϵ, 0.600; θ, 0.950. Wing, 1.7 to 1.8 millimeters long, 0.6 millimeter wide.

Hind legs.—Much longer than body; hairs on tarsal segments arranged in bands. Total length, 3.0 to 3.1 millimeters.

Genitalia.—Spermathecæ barrel-shaped (fig. 1, *e*); the ducts join at an acute angle into a common one at a point about 0.250 millimeter from the genital opening.

MALE

Slightly smaller than female in all measurements and lighter in color. Buccal armature without pigmented area; teeth fewer, slightly separated, a triffle longer and larger than those of female (fig. 1, *c*). Measurements of important wing veins of one male are as follows: α, 0.400 millimeter; β, 0.200; γ, 0.200; δ, 0.250; ϵ, 0.500; θ, 0.700. The upper branch of second longitudinal vein is twice the distance between the forks; δ is one and one-fourth times the distance between the two forks.

Genitalia (fig. 1, f).—Proximal segment of superior clasper over twice the length of the distal; distal segment armed with four, pointed, apical macrochætæ; intermediate appendage finger-shaped with hairs on its distal half. Intromittent organ paired; genital filaments not protruding. Inferior claspers bear hairs but are unarmed.

DIFFERENTIAL DIAGNOSIS

Only two species of *Phlebotomus* have been recorded from the Philippines; namely, *P. nicnic* Banks and *P. philippinensis* Manalang.[3]

[3] Philip. Journ. Sci. 41 (1929) 175.

The new species, *P. manganus,* is very similar to *P. nicnic;* both are recumbent-haired and have the type of male genitalia and female spermathecæ found in *P. minutus* Rondani. The chief differences between the two are given in Table 1.

TABLE 1.—*Chief differences between Phlebotomus nicnic Banks and P. manganus sp. nov.*

Part measured.	*P. nicnic.*	*P. manganus.*
Female:		
Buccal armature—		
Pigmented area	Cylindrical	Triangular.
Teeth	Two or more rows, few short, conical and separate. [a]	One row, very numerous slender, not separate.
Wing: Relative length, upper branch 2d vein and distance between the two forks.	Equal	Upper branch almost twice the distance between the two forks.
Male:		
Buccal armature—		
Pigmented area	Present; cylindrical	Absent.
Teeth	Same as those in female	Fewer, slightly larger than those in female, separated.
Genitalia—		
Machrochætæ	Three apical and 1 subapical	All apical.
Mesial surface of proximal segment of superior clasper.	With thick brush of stout hairs.	No such brush.

[a] Manalang, C., Philip. Journ. Sci. 41 (1930) 169.

Phlebotomus philippinensis is an erect-haired fly and need not be confused with *P. manganus,* although in specimens with rubbed-off hairs, the wing volumes of the two are quite similar. The lens, however, will reveal the characteristic very short fourth palpal segment and the five genital macrochætæ of the male *P. philippinensis.* A comparison of the buccopharyngeal armatures of *P. manganus* with those of the known Asiatic species of the *P. minutus* groups (*P. minutus* Rondani, *P. minutus* var. *antennatus* Newstead, *P. babu* Annandale, *P. shorttii* Adler and Theodor, *P. africanus* Newstead, *P. palestinensis* Adler and Theodor, *P. montanus* Sinton, and *P. perturbans* de Meijere)[4] showed distinct differences either in the number, shape, and arrangement of buccal teeth, the presence or shape of the pigmented area in one or both sexes, or the character of the pharyngeal armature.

[4] Sinton, J. A., Ind. Journ. Med. Research 15 (1927) 29; Patton and Hindle, Proc. Roy. Soc. (Ser. B) C (1926) 405–412; Patton and Hindle, Proc. Roy. Soc. (Ser. B) C–II (1928) 533–551.

TABLE 2.—*Measurements of Phlebotomus manganus sp. nov., in millimeters.*

Part measured.	Male.			Female.		
	1	2	3	1	2	3
Body:						
Clypeus and head	--------	0.350	0.300	0.350	0.360	0.375
Thorax	0.500	0.500	0.450	0.550	0.560	0.550
Abdomen	--------	1.150	1.200	1.250	1.200	--------
Superior clasper, segment 1	0.250	0.237	0.225	0.150	0.150	--------
Total length	--------	2.237	2.175	2.300	2.270	--------
Labium	0.250	0.250	0.225	0.300	0.300	0.300
Antenna:						
Segment III	0.287	0.300	0.300	0.290	0.300	0.330
Segment IV	0.125	0.125	0.125	0.116	0.125	0.125
Segment V	0.125	0.125	0.125	0.116	0.125	0.125
Segment VI	0.125	0.125	0.125	0.116	0.125	0.125
Segments XII to XVI	--------	0.400	0.450	0.550	--------	0.437
Segments I, II, and VII to XI	--------	0.775	0.725	0.680	--------	0.762
Total length	--------	1.850	1.850	1.868	--------	1.904
Palp:						
Segment 1	0.037	0.037	0.037	0.037	0.037	0.050
Segment 2	0.100	0.112	0.112	0.112	0.112	0.125
Segment 3	0.125	0.150	0.137	0.140	0.150	0.150
Segment 4	0.200	0.212	0.212	0.200	0.200	0.206
Segment 5	0.312	0.275	0.287	0.300	0.300	0.400
Total length	0.774	0.786	0.785	0.789	0.799	0.931
Wing:						
Length	1.600	1.700	1.700	1.700	1.800	1.700
Width	0.500	0.500	0.475	0.600	0.600	0.600
Hind leg:						
Femur	0.650	0.750	0.700	0.750	0.750	0.775
Tibia	0.950	0.975	0.975	1.100	1.100	1.060
Tarsus, segment 1	0.460	0.475	0.450	0.500	0.550	0.500
Tarsus, segments 2 to 5	0.600	0.650	0.600	0.650	0.700	0.675
Total length	2.660	2.850	2.725	3.000	3.100	3.010
Superior clasper:						
Segment 1	0.250	0.237	0.225	--------	--------	--------
Segment 2	0.100	0.108	0.100	--------	--------	--------
Intromittent organ	0.100	0.100	0.100	--------	--------	--------

SUMMARY

1. *Phlebotomus manganus*, a new species from the Philippines, is reported and described. Specimens were collected from a tree hole, associated with *P. nicnic* Banks.

2. The species is recumbent-haired and belongs to the *P. minutus* Rondani group.

3. Chief characteristics are given which differentiate it from *P. nicnic*, *P. philippinensis*, and the other known Asiatic species.

ILLUSTRATIONS

TEXT FIG. 1. *Phlebotomus manganus* sp. nov., drawn from potash preparations, except the spermatheca; *a*, buccal armature, female; *b*, pharyngeal bulb, female; *c*, buccal armature, male; *d*, wing, female; *e*, spermatheca (dissected fresh, mounted in 5 per cent formalin); *f*, genitalia, male (*ps*, proximal segment; *ds*, distal segment; *m*, macrochætæ; *ia*, intermediate appendage; *io*, intromittent organ; *ic*, inferior clasper); *g*, palp, female.

PHLEBOTOMUS HITCHENSI, A NEW PHILIPPINE SPECIES [1]

By C. MANALANG

Of the Philippine Health Service, Manila

ONE TEXT FIGURE

The sand flies were found in tree holes, with a red-ant house, and under lifted fragments of tree bark in a small jungle a few hundred meters northeast of the field laboratory. The first specimens captured October 22 were two blood-engorged females and two male *P. nicnic* Banks. On the following day, two blood-engorged females and nine males with few *P. nicnic* were again caught. The place is a favorite pasture for cows and carabaos, and the flies might have obtained their blood meals from them. Of the three other local species, *P. nicnic* is the only one frequently found with blood. Judging from the male genitalia, the new species belongs to the *P. minutus* Rondani group.

PHLEBOTOMUS HITCHENSI sp. nov. Text fig. 1.

DESCRIPTION OF FEMALE

The species is by far the largest of the local species, the body being over 2.5 millimeters long, the wings more than 2 by 0.7 millimeter, the antenna 2 millimeters, and the hind legs about 4 millimeters long. It is pale gray, silvery by transmitted light, with the hairs on the dorsum of the abdomen recumbent; those on the clypeus, thorax, and first abdominal segment erect.

Palps.—Second segment about twice the first; third and fourth segments equal or the former a trifle longer than the latter; fifth segment about equal to the combined lengths of the third and fourth segments. All the segments are covered with hairs and bent scales. Total length of palpus, 0.65 millimeter (fig. 1, *f*).

[1] From the field laboratory of the division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan Province, Luzon. Submitted for publication, October 29, 1929.

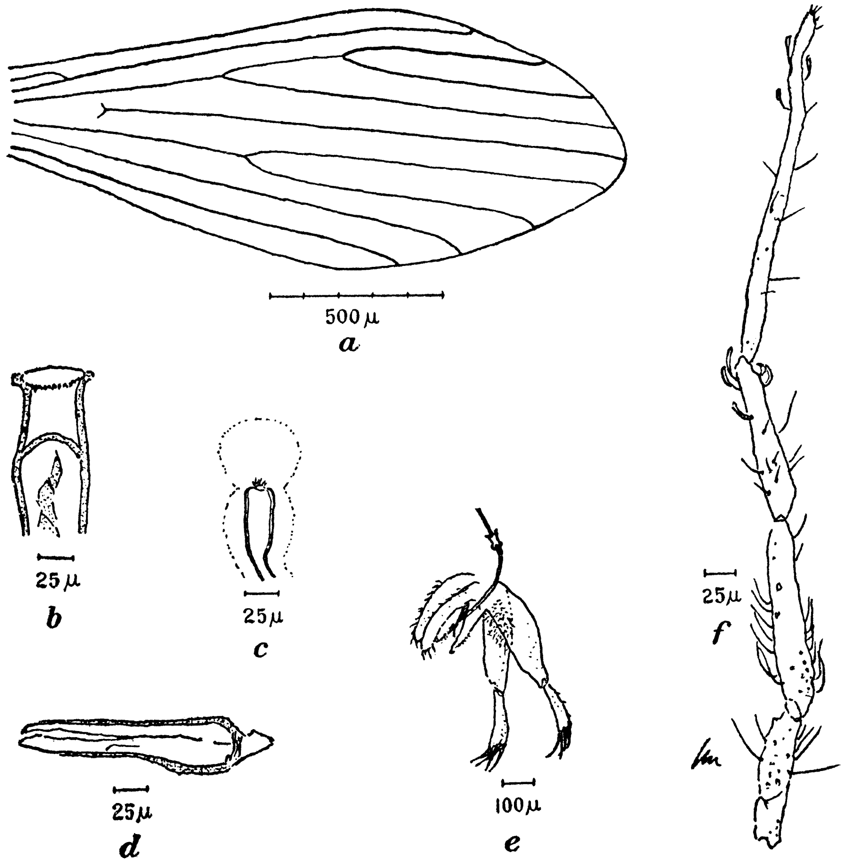

FIG. 1. *Phlebotomus hitchensi* sp. nov.; *a*, denuded wing of female; *b*, buccal armature of female; *c*, spermatheca; *d*, pharyngeal bulb of female; *e*, genitalia of male; *f*, palpus of female: (Drawn by the author from potash preparations; except *c*, which is from fresh material.)

Antennæ.—Third segment a little less than three times the fourth. Very pale geniculate spines present. Total length, 1.96 millimeters.

Buccopharyngeal armatures.—Buccal armature somewhat similar to that of *P. nicnic* but without pigmented area (not even rudimentary) and with only one row of about ten separate minute low conical and highly refractile teeth (fig. 1, *b*). Pharyngeal bulb not flask-shaped; without visible teeth. The posterior extremity shows few transverse ridges (fig. 1, *d*).

Thorax.—No flat scales present on the pleuræ. Dorsum of the thorax with long, slightly curved, vertical hairs. Integument brown laterally and dark brown dorsally.

Abdomen.—Dorsum with recumbent hairs, except the first segment which carries a tuft of vertical ones, bent slightly forward. Total length of the body including clypeus, 2.6 millimeters.

Wings.—Voluminous and thickly covered with long gray hairs. Anterior and posterior curvatures about the same with the third longitudinal vein dividing the appendage into approximately two equal parts. Relative lengths of important vein portions are: $\gamma = \beta$; $\delta = 1.25$ times either γ or β; $\alpha =$ almost twice β (fig. 1, *a*).

Hind legs.—Total length 1.2 to 1.25 times length of body; femur and tarsus segment 1 about equal in length or the latter slightly longer; the combined lengths of the two about equal to the length of the tibia. Total length, 3.5 to 4.13 millimeters.

Spermathecæ.—Bottle-shaped with smooth wall; they measure 25 μ by 75 μ (fig. 1, *c*).

DESCRIPTION OF MALE

Paler and about equal in size or a trifle smaller than the female. Antennæ of the male slightly the longer. Relative lengths of wing veins differ from female as follows: $\gamma = \delta$; $\beta = 1.4$ times γ; $\alpha = 1.5$ times β.

Genitalia.—The length of the proximal segment of the superior clasper is twice that of the distal. A brush of slender hairs is present on the mesial surface of the proximal segments. The distal segment carries four long pointed and colorless macrochætæ, two apical and two subapical. The intermediate lobe is finger-shaped, with hairs on its distal half. The intromittent organ is paired; genital filaments slightly protruding in one of the two males mounted. The inferior claspers are not armed (fig. 1, *e*).

DIAGNOSIS

Phlebotomus philippinensis Manalang[3] is an erect-haired fly, and unless the hairs have been rubbed off from the dorsum of the abdomen, the differentiation is simple. This species has five macrochætæ, instead of four as in *P. hitchensi;* the spermatheca in the former is carrot-shaped with eleven crenulations; in the latter it is smooth and bottle-shaped. The bucco-pharyngeal armatures are also very different.

[3] Manalang, C., Philip. Journ. Sci. 41 (1930) 175.

TABLE 1.—*Measurements of parts of the body of Phlebotomus hitchensi sp. nov.*

Part.	Female 1.	Female 2.	Male 1.	Male 2.
Body:	*mm.*	*mm.*	*mm.*	*mm.*
Clypeus and head	0.350	0.325	0.350	0.350
Thorax	0.550	0.600	0.460	0.460
Abdomen	1.550	1.600	1.400	1.300
Superior clasper, segment 1	0.150	0.150	0.300	0.300
Total length	2.600	2.675	2.510	2.410
Labium	0.200	0.200	0.200	----------
Antenna:				
Segment III	0.360	0.360	0.425	0.400
Segment IV	0.125	0.125	0.160	0.160
Segment V	0.125	0.125	0.160	0.160
Segment VI	0.125	0.125	0.160	0.160
Segments XII to XVI	0.450	----------	0.466	0.450
Segments I, II, and VII to XI	0.775	----------	0.950	0.950
Total length	1.960	----------	2.321	2.280
Palp:				
Segment 1	0.050	0.037	0.037	----------
Segment 2	0.075	0.087	0.087	----------
Segment 3	0.137	0.125	0.125	----------
Segment 4	0.125	0.125	0.112	----------
Segment 5	0.262	0.275	0.238	----------
Total length	0.649	0.649	0.599	----------
Wing:				
Length	2.200	2.100	1.800	1.800
Breadth	0.750	0.700	0.560	----------
Hind leg:				
Femur	0.750	0.800	0.800	0.800
Tibia	1.400	1.650	1.700	1.660
Tarsus, segment 1	0.750	0.830	0.880	0.850
Tarsus, segments 2 to 5	0.800	0.850	0.850	0.800
Total length [a]	3.700	4.130	4.230	4.110
Superior clasper, male:				
Segment 1	----------	----------	0.300	0.300
Segment 2	----------	----------	[b] 0.150	0.150
Intromittent organ	----------	----------	0.100	0.100

[a] Not including coxa and trochanter. [b] Genital filaments slightly protruding.

Of his class B (recumbent-haired) of the Asiatic species of *Phlebotomus,* Sinton[4] says: "The buccal armature and pigmented area usually well developed and in all the species examined has a specific morphology." Search of the literature in which this structure has been studied among the Asiatic members of the *P. minutus* group failed to show a species without the pigmented area in the female. *Phlebotomus hitchensi* has

[4] Ind. Journ. Med. Res. 16 (1928) 299.

not even a trace of rudimentary pigmented area and is apparently the first-recorded species of this group not possessing this structure.

This species is named for Maj. A. P. Hitchens, United States Army Medical Corps, who showed great interest in scientific health administration of the Philippines while adviser to the Governor-General.

TABLE 2.—*Differential characters of Phlebotomus hitchensi and the other local species of the minutus group.*

Area or organ.	*P. nicnic* Banks. [a]	*P. mcnganus* Manalang. [b]	*P. hitchensi* sp. nov.
Female:			
Buccal armature—			
a, pigmented area	Cylindrical	Triangular	None.
b, teeth	Two or more rows, few conical and separate.	One row, very many, slender, not separate.	One row, about ten, separate, low, and conical.
Wing, α and β	Equal	$\alpha = 2 \times \beta$	$\alpha = 2 \times \beta$.
Spermathecæ	Barrel-shaped	Barrel-shaped	Bottle-shaped.
Male:			
Buccal armature—			
a, pigmented area	Same as female	None	None.
b, teeth	do	Fewer, larger, more separate than in female.	Same as female.
Genitalia; macrochætæ	Three apical and 1 subapical (pigmented).	All apical (pigmented).	Two apical and 2 subapical (not pigmented).
Mesial surface, proximal segment, superior clasper.	With thick brush of long stout hairs.	None	Thick brush of short slender hairs.

[a] Philip. Journ. Sci. 41 (1930) 169. [b] Philip. Journ. Sci. 42 (1930) 283.

SUMMARY

1. *Phlebotomus hitchensi,* a new species from the Philippines belonging to the *minutus* group, is reported and described.

2. Differential characters are given to distinguish it from the other local species.

3. As far as can be determined, all the known Asiatic species of the *minutus* group in which the buccal armature has been worked out, possess a well-developed pigmented area in the female, the morphology of which is of specific value; *P. hitchensi* is apparently the first-recorded species in which this is absent.

ILLUSTRATION

TEXT FIG. 1. *Phlebotomus hitchensi* sp. nov.; *a*, denuded wing of female; *b*, buccal armature of female; *c*, spermatheca; *d*, pharyngeal bulb of female; *e*, genitalia of male; *f*, palpus of female. (Drawn by the author from potash preparations; except *c*, which is from fresh material.)

PHLEBOTOMUS HEISERI, A NEW SPECIES [1]

By C. MANALANG

Of the Philippine Health Service, Manila

ONE TEXT FIGURE

The first specimen noted of this new phlebotomus was a male caught October 23, 1929, with *P. hitchensi* Manalang [2] on tree trunks in the vicinity of the laboratory. More flies of both sexes were caught November 1 and thereafter, not only in Tungkong Manga district but also in La Mesa, Novaliches, Rizal Province, Santo Cristo and Bigti-Norzagaray, Bulacan Province, Luzon. It is a medium-sized fly; the female is very dark gray or almost black, and when blood engorged frequently carries its wings horizontally. Like *P. nicnic* Banks,[3] *P. manganus* Manalang,[4] and *P. hitchensi*, it is recumbent-haired and has the *P. minutus* Rondani type of male genitalia.

PHLEBOTOMUS HEISERI sp. nov. Fig. 1.

DESCRIPTION OF FEMALE

The female is 2.5 millimeters long, and the darkest of all the known local species; unlike the other species, it often carries its wings horizontally, particularly when blood engorged.

Palps.—First segment a little less than half the length of the 2d; 3d segment slightly longer than the 4th; the combined lengths of the 2d and 3d segments is about equal to that of the 5th. All segments are covered with hairs and bent scales. Total length, 0.5 to 0.54 millimeter (fig. 1, *g*).

Antennæ.—Segment III greater than half the combined lengths of segments XII to XVI or the combined lengths of segments IV and V. Total length, 1.85 to 1.87 millimeters. Geniculate spines present.

[1] From the field laboratory of the division of malaria control, Philippine Health Service, Tungkong Manga, Bulacan Province, Luzon. Submitted for publication, November, 1929.

[2] Philip. Journ. Sci. 42 (1930) 291.

[3] Philip. Journ. Sci. 41 (1930) 169.

[4] Philip. Journ. Sci. 42 (1930) 283.

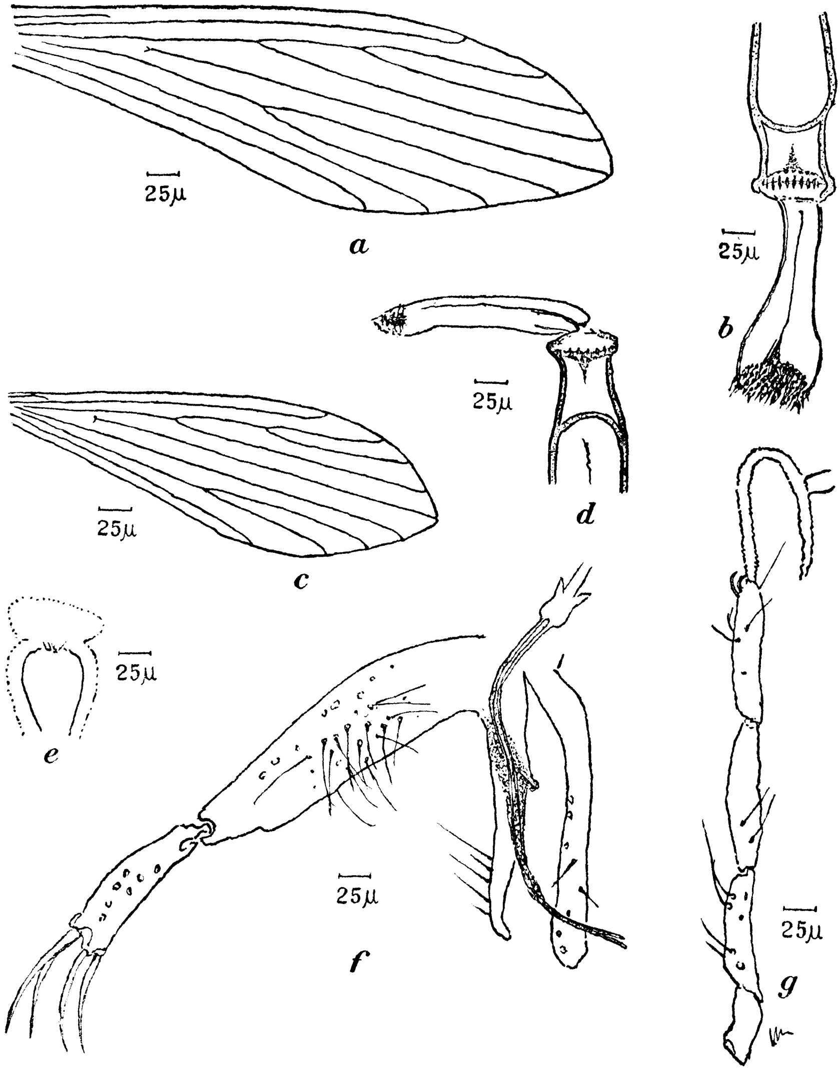

FIG. 1. *Phlebotomus heiseri* sp. nov.; *a*, denuded wing of the female; *b*, buccopharyngeal armatures of the female; *c*, denuded wing of the male; *d*, buccopharyngeal armatures of the male; *e*, spermatheca; *f*, male genitalia; *g*, palpus of the female. (Drawn by the author from potash preparations; except *e*, which is from a fresh specimen.)

Buccopharyngeal armatures.—The posterior part of the floor of the buccal cavity carries two rows of teeth, an anterior row of ten or twelve short blunt teeth and a posterior row of about the same number of large elongated, somewhat lance-shaped, deeply set teeth. They measure about 5 microns in length, the largest and longest among the known local species. The pig-

mented area is triangular, its acute apex pointing anteriorly. The posterior end of the pharyngeal bulb is also unique, being covered entirely by a thick brush of numerous, closely set, long, stout spines, all directed posteriorly (fig. 1, *b*).

Thorax.—There are no scales on the pleuræ. The dorsum is covered with long black vertical hairs. The integument is uniformly dark brown.

Abdomen.—The hairs on the dorsum are recumbent, except those on the first segment which are erect. The integument is dark brown.

Wings.—The wings are thickly covered with long black hairs. The posterior border is slightly more curved than the anterior. The venation in one female shows γ, β, and δ to be about equal and α not quite twice β (fig. 1, *a*). In another female, γ and β are equal but noticeably shorter than δ, while α is slightly more than twice β. The wings are 1.8 to 1.9 millimeters long by 0.55 millimeter wide.

Hind legs.—The femur is longer than tarsal segment 1 and about equal to the combined lengths of tarsal segments 2 to 5. The total length is about 3 millimeters.

Spermathecæ.—The spermathecæ are pear-shaped with the ducts joining at a wide angle some distance above the genital opening (fig. 1, *e*).

DESCRIPTION OF MALE

The male is smaller than the female and pale gray. The total body length is about 2 millimeters. The wings are more symmetrically lanceolate than those of the female. The venation differs from the female in that γ is less than β; α twice δ; and δ is less than either γ or β (fig. 1, *c*). The buccal armature has fewer and smaller teeth than that of the female. About half of the males have an extra row of two or three small teeth next to the pigmented area. The pigmented area is frequently carrot-shaped. The pharyngeal bulb has no brush of stout spines, but transverse folds on which are set minute slender spines pointed backwards (fig. 1, *d*). The genitalia are similar to those of the other local members of the *minutus* group, with four macrochætæ (2 apical and 2 subapical) on the distal segment of the superior clasper. The mesial surface of the proximal segment of this clasper has long rather closely set hairs. The intromittent organ is paired, and in many specimens the genital filaments are markedly protruded (fig. 1, *f*).

TABLE 1.—*Measurements of parts of the body of Phlebotomus heiseri sp. nov.*

	Male 1.	Male 2.	Female 1.	Female 2.
Body:	*mm.*	*mm.*	*mm.*	*mm.*
Clypeus and head	0.300	----------	0.350	0.350
Thorax	0.400	0.430	0.600	0.575
Abdomen	1.000	1.100	1.400	1.400
Superior clasper, segment 1	0.200	0.250	0.150	0.175
Total length	1.900	----------	2.500	2.490
Labium	0.150	----------	0.200	0.200
Antenna:				
Segment III	0.330	0.330	0.275	0.275
Segment IV	0.150	0.150	0.125	0.125
Segment V	0.150	0.150	0.125	0.125
Segment VI	0.150	0.150	0.125	0.125
Segments XII to XVI	0.400	0.430	0.450	0.425
Segments, I, II, and VII to XI	0.600	0.580	0.775	0.775
Total length	1.780	1.790	1.875	1.850
Palp:				
Segment 1	0.025	0.037	0.037	0.037
Segment 2	0.075	0.075	0.081	0.087
Segment 3	0.108	0.100	.112	0.112
Segment 4	0.087	0.087	0.100	0.108
Segment 5	0.150	0.175	0.200	0.200
Total length	0.445	0.474	0.500	0.544
Wing:				
Length	1.600	1.600	1.900	1.800
Breadth	0.430	0.425	0.550	0.550
Hind leg:				
Femur	0.550	0.650	0.750	0.800
Tibia	0.800	1.000	1.000	1.100
Tarsus, segment 1	0.425	0.500	0.530	0.500
Tarsus, segments 2 to 5	0.550	0.650	0.750	0.725
Total length [a]	2.325	2.800	3.030	3.125
Superior clasper of male:				
Segment 1	0.200	0.250	----------	----------
Segment 2	0.100	0.112	----------	----------
Intromittent organ	[b] 0.075	0.100	----------	----------

[a] Not including coxa and trochanter. [b] Genital filaments protruding.

Phlebotomus philippinensis Manalang[5] is easily distinguished from the new species, being an erect-haired fly, with five macrochætæ in the male genitalia, and carrot-shaped crenulated spermathecæ. Its buccal and pharyngeal armatures are also very characteristic. The buccopharyngeal armatures of *P. heiseri* are different from those of the other known Asiatic species in which these structures have been worked out.[6]

[5] Philip. Journn. Sci. **41** (1930) 175.

[6] Indian Journ. Med. Res. **15** (1927) 29; Bull. Ent. Res. **16** (1926) 399; Proc. Roy. Soc. (§ B) **100** (1926) 405; Proc. Roy. Soc. (§ B) **102** (1928) 533.

TABLE 2.—*Differential characters of Phlebotomus heiseri and the other local species of the minutus group.*

Area or organ.	*P. nicnic* Banks.	*P. manganus* Manalang.	*P. hitchensi* Manalang.	*P. heiseri* sp. nov.
Female:				
Buccal armature—				
Pigmented area.	Cylindrical	Triangular	None	Triangular (pale).
Teeth	Two or more rows, few conical and separate.	One row, very many slender, not separate.	One row, about 10 separate, low and conical.	Two rows; anterior short, posterior long.
Pharyngeal bulb, posterior end.	Several rows of slender spines pointing backwards.	Many long filamentous spines pointing backwards.	No spines	Thick brush of long stout spines.
Wing, α and β	$\alpha = \beta$	$\alpha = 2 \times \beta$	$\alpha = 2 \times \beta$	$\alpha >$ or $< 2\beta$
Spermathecæ	Barrel-shaped	Barrel-shaped	Bottle-shaped	Pear-shaped.
Male:				
Buccal armature—				
Pigmented area.	Same as female	None	None	Same as female.
Teeth	do	Fewer, larger and more separate than female.	Same as female.	Fewer than female.
Genitalia: macrochætæ	Three apical, one subapical (pigmented).	All apical (pigmented).	Two apical, two subapical (not pigmented).	Two apical, two subapical (not pigmented).
Mesial surface proximal segment, superior clasper.	With thick brush of long stout hairs.	None	Brush of slender hairs.	Thin brush of long hairs.

The new phlebotomus is named for Dr. Victor G. Heiser, internationally known sanitarian, formerly director of the Bureau of Health of the Philippine Islands and at present member of the International Health Division, Rockefeller Foundation, New York.

SUMMARY

1. *Phlebotomus heiseri* sp. nov., a Philippine member of the *P. minutus* Rondani group, is reported and described.

2. Differential diagnosis is given to distinguish it from other local species.

ILLUSTRATIONS

TEXT FIG. 1. *Phlebotomus heiseri* sp. nov.; *a*, denuded wing of the female; *b*, buccopharyngeal armatures of the female; *c*, denuded wing of the male; *d*, buccopharyngeal armatures of the male; *e*, spermatheca; *f*, male genitalia; *g*, palpus of the female. (Drawn by the author from potash preparations; except *e*, which is from a fresh specimen.)

ABILITY OF MATURE GRUBS OF LEUCOPHOLIS IRRORATA (COLEOPTERA, MELOLONTHIDÆ) TO SURVIVE SUBMERGENCE IN WATER

By A. W. Lopez

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INTRODUCTION

Several species of white grubs are very prevalent in the Philippine Islands, especially in Occidental Negros, and are doing considerable damage to sugar cane. Several hacenderos had planned to drown the grubs by flooding their infested fields with water for a short period of time. This study was undertaken to determine whether or not the grubs could be killed by submerging infested fields.

MATERIAL AND METHODS

The experiment was carried out in the entomology laboratory of the Philippine Sugar Association located at the La Carlota Sugar Central, Occidental Negros. It was started October 30, 1929, and was completed November 3, 1929.

Mature grubs of *Leucopholis irrorata* Chevrolat were used, since it is this species that is found in largest numbers. Fifty 5-by-7-inch battery jars were half filled with soil from a badly infested cane field of Hacienda Candaguit, La Carlota Central. The soil was a sandy loam. Four grubs from the same field were placed in the soil of each jar, and forty jars were filled with tap water. Ten jars constituted the control.

After the periods of time indicated in Table 1 had elapsed, the grubs were taken from the soil, washed off, and laid upon a board. Table 1 shows the results obtained.

The first signs of life in the grubs submerged 24 hours occurred in 3 minutes; in those submerged 48 hours, 15 minutes; in those submerged 72 hours, 20 minutes; and in those submerged 96 hours, 75 minutes. In all except the 96-hour lot, the final count was made after two hours exposure to the air. The 96-hour count was made after four hours.

TABLE 1.—*Showing plan and results of experiment.*

Symbol.	Jars.	Buc-an.	Hours submerg-ed.	Alive.	
				Number.	Per cent.
A	10	40	24	36	90
B	10	40	48	28	70
C	10	40	72	14	35
D	10	40	96	10	25
X	10	40	[a]	29	72.5

[a] Control; counted after 100 hours.

DISCUSSION

While the experimental conditions are not field ones, in some respects they are more severe. The sudden application of water to the jars would prevent the grubs from making any preparations they might make should water come upon them slowly as in an inundation of a field.

On the other hand, removing the grubs from the water and washing off the mud, thus immediately exposing them to the air, is a favorable condition they would not encounter as the water slowly drained from a field.

It may be seen from the table that 27.5 per cent of the control grubs were dead at the end of the 100-hour period. The mortality of grubs collected in the field and transported to the laboratory is somewhat high, so that all the deaths cannot be attributed to the water.

SUMMARY AND CONCLUSION

Under the conditions of this experiment 90 per cent of *Leucopholis irrorata* grubs survived a 24-hour submergence period; 70 per cent survived a 48-hour period; 35 per cent survived a 72-hour period, and 25 per cent survived a 96-hour period. At the end of a 100-hour period 72.5 per cent of the control grubs were alive.

Flooding fields infested with *L. irrorata,* to be effective as a control measure, apparently should be carried on longer than ninety-six hours.

INVESTIGATIONS ON FISH PRESERVATION AT ESTANCIA, PANAY, PHILIPPINE ISLANDS

By HERACLIO R. MONTALBAN
Of the Bureau of Science, Manila

FIVE PLATES

INTRODUCTION

Act 3307 of the Philippine Legislature, passed December 2, 1906, provided for the reorganization of the division of fisheries, of the Bureau of Science, and appropriated funds for its activities. Accordingly, in 1927, a laboratory was established at Estancia, Panay, where during the sardine season of that year the writer conducted experiments on various methods of salting, drying, pickling, and smoking fish. This work was instituted in order to work out means by which the local methods of preserving fish could be improved. No attempt has been made to introduce new methods, but it was deemed advisable to find out first if the procedures in use were defective, and then if defects were discovered to make the improvements that would apply to the local needs. The standard of the goods turned out locally needs to be raised, and as a result of the investigations it was shown that it is possible to produce first-grade articles which can be sold as cheaply as the old products and still give a good margin to the dealer.

Estancia was selected as the site for the experimental station because of its great importance as a fishing center. It has long been famous for the enormous quantities of sardines taken from its waters and for its industry in the dry-salted product from this fish, known locally as "binoro." This industry alone is valued at nearly half a million pesos, and around 75,000 sacks (2,625 tons) of salt are employed in the preparation of this product each sardine season. Besides the sardines, fishes of many other species are caught in large numbers.

The following fishes, named in the order of their importance, were used in connection with this study:

Sardine, *Sardinella longiceps* Cuvier and Valenciennes; Visayan, toloy.
Japanese mackerel, *Scomber japonicus* Houttuyn; Visayan, bulao.

Chub mackerel, *Scomber macrolepidotus* Rüppell; Visayan, aguma-a.
Spanish mackerel, *Scomberomorus commersoni* Lacépède; Visayan, tanguingue.
Pampano, *Caranx* sp.; Visayan, pagapa.
Snapper, *Lutianus* sp.; Visayan, maya-maya.
Young grouper, *Epinephelus* sp.; Visayan, inid.

ESTANCIA METHODS OF PRESERVING FISH

SARDINES CURED IN VARIOUS WAYS

Dry-salted or kench-cured sardines (Visayan, binoro).—At Estancia the sardines are usually removed from the traps early in the morning and are transported in sailing boats to the salting plants, which are in most cases the property of the fishermen and fish merchants. Here the sardines are placed in the vats or tanks, where they remain in the concentrated salt solution coming from the large bamboo baskets of cured sardines. The solution is called "blood brine" or "blood pickle" and is considered much better than any newly made brine. It is always saved and used over and over. There is apparently no effort to make fresh brine by directly dissolving salt in water. If no ready brine is available, the sardines are salted in the vats or tanks to form their own pickle, and sometimes the fish are stirred up with a considerable amount of salt on the concrete floors, and the pickle formed is collected in the vats and tanks.

Ordinarily the sardines are kept in the brine for two hours, but if the catches are unusually large and there are not enough workers available, the fish remain in the pickle for a longer period. The sardines apparently become hard in the pickle and most of their blood and slime is removed. The fish are then taken from the brine tank and piled on the draining floor ready for packing, which is done by men, women, boys, and girls. In packing, a considerable amount of salt is first spread on the bottom of the large bamboo baskets (*bulto* or *taboñgos*), and then on each layer of fish, and plenty on the top to make up for the dissolved salt which runs out. The fish are packed on their sides and in rows.

A marked increase in the bulk of the contents of a basket is observed for the first three or four days, due undoubtedly to the formation of gas resulting from partial decomposition in the fish. Some shrinkage ensues, which amounts to about one-fifth of the original bulk. It is made up with fish of the same lot before a sale is made.

The basket containers are of different sizes and are classified roughly as first, second, and third. In some cases petroleum or gasoline boxes are used. The result is that the dealers and the purchasers only guess at the number of sardines a basket or box contains.

A basket of the first class contains from 4,000 to 5,000 full-grown sardines, or *sipi*, and requires for both brining and packing approximately two sacks of Malabon salt weighing about 35 kilograms each. From 3,000 to 4,000 fish are packed in a second-class basket and nearly one and a half sacks of salt are used. A third-class basket holding about 2,500 fish needs a sack of salt, and an empty petroleum or gasoline box containing 1,000 sardines needs nearly half a sack.

Pickle-cured sardines (*Visayan, tinabal*).—Fresh, full-grown or young sardines are washed in sea water, taken inside the salting shed, and put in the brine vats or tanks, where they are kept in a saturated salt solution. After two or three hours the fish become hardened and are then taken out by means of scoop nets onto the concrete floors. Here salt is sprinkled over the fish at frequent intervals, the amount of salt used being equal to that used for the packing of *binoro*. The sardines, after being thoroughly stirred, or "roused," with shovels, are packed in petroleum or gasoline cans and in barrels. When barrels are used, they are headed up right after they are filled. They are rolled out, and a hole is bored in the bilge. The hole is loosely plugged to let the gas formed inside the barrels escape. The fish are kept in this condition for a week or two, and fish of the same age or pack are used to fill the barrels. When ready to be shipped the barrels are tightly plugged. Petroleum and gasoline cans, because of their abundance, are oftentimes used. The cans that have a small round hole at one corner of the top are preferred, although other kinds are used. After the cans are filled they are laid aside with the holes loosely plugged, to let the fish cure. When sufficient time has elapsed, say a week or two, the holes are provided with tin covers and soldered.

In putting up the young sardines, one of the local dealers does not keep the fresh fish in brine, but sprinkles a little salt on them and lets the fish stay in the vats or tanks overnight. The next day the *tamisot*, or young fish, are mixed thoroughly with salt and placed in the cans as above. About two parts of salt to five parts of fish are used. The filled cans are left loosely

plugged from a few days to about a month. Fine-ground Ilocano salt is used in the preparation of this product.

Tinabal is a more or less fermented product, not much different from the bagoong made in the Ilocos provinces and other regions. It is mostly exported to Manila, where it brings a good price. A little is prepared for local consumption after the sardine season is over, when the other kinds of fishes are not available.

Tinabal made from young sardines, after having aged for a year or longer, is converted into sauce, or *patis*. A mixture of equal portions of tinabal and water is cooked at the boiling point for six hours or longer, until it is reduced to one-half its original volume. The resulting product is strained and put in new cans which are sealed ready for shipment.

S*moked sardines* (*Visayan, tinapahan or tinapa*).—The preparation of tinapa is carried on by two local dealers and their method, with slight modifications, is similar to that employed by the Chinese of Tondo, Manila. Mostly full-grown sardines are smoked. The fish, which are landed at Estancia, are washed in sea water before they are taken inside the smoking shed. They are brined in the vats or tanks in the same manner as in making binoro, except that the fish remain in the brine not longer than two or three hours. From the brine the sardines are placed in baskets (*kaeng*), which are dipped in boiling water until the fish are cooked. The cooking of the sardines, which are exceedingly fat, has one particular advantage in that almost all the excess fat is removed from the fish. Large kettles are used for cooking, and these are placed over concrete or earthen furnaces (*pilon*). The cooked fish dry quickly due to the moisture evaporating from them, but one of the local merchants puts the sardines in the sunshine to dry for an hour or two. This practice allows them to cool at the same time. Sixty sardines are then packed carefully in a round, coarsely woven, bamboo tray (*lastay*), which is 35 centimeters in diameter. Each tray, covered with a tightly woven basket, is placed over an opening of the furnace to smoke. One of the dealers has a series of fifteen concrete furnaces, joined together with partitions between them, forming a long narrow outfit for smoking purposes. The other merchant owns twenty earthen furnaces; each is independent of the others and can be taken apart. The furnaces have holes on top for the smoke to pass out and these are slightly smaller in diameter than the trays. There are 2.5-centimeter holes on both the front and back sides of the furnaces to let

air enter. Smoke is produced in the furnaces from *laua-an* sawdust. After three or four hours smoking, the sardines are turned over, the purpose being to give both sides of the fish an even dark brown color. About five or six hours are necessary for smoking a basket of sipi. The smoked fish sell at Estancia for 60 to 75 centavos per hundred, wholesale. These will keep but a short time, unless put in cold storage.

Sardines cooked in vinegar (*Visayan, pinacsio*).—Fresh full-grown sardines, after being thoroughly cleaned with water, are placed in salting vats or tanks which contain a saturated brine solution. The sardines are left in the brine two or three hours, taken out to drain, and packed carefully in straight rows in petroleum and gasoline cans until these are filled to the top. At the bottom of the cans are placed thinly sliced stems of coco-palm leaves to prevent the burning of the fish, and on each layer of fish a little salt is sprinkled to give the desired flavor. Coconut vinegar is poured over the fish until they are well covered, and the filled cans are set on ovens made of petroleum and gasoline cans also. The fish are next cooked, *bac-hao* wood being chiefly used as firewood. The cover of the cans is folded back in place and an extra cover of a piece of *buri bayon* is provided. The cooked fish, which will not keep long, is shipped immediately to Iloilo and various places in Capiz Province. In some cases the liquor is purposely drained through a hole at the bottom of the can which is plugged up tightly afterwards.

Dried split sardines (*Visayan, pinakas*).—The fresh sardines are dressed and cleaned immediately after they are carried ashore. In dressing they are split along the back next to the backbone from the head to the tail; the gills and the entrails are removed. After the dressing, the fish are washed in sea water and placed in saturated brine overnight. Early the next morning, the cured fish are taken outdoors to dry on the woven split-bamboo platforms (*banata*), the fish being laid with the flesh side down. One day of good sunshine is sufficient to dry the fish. Only full-grown sardines are prepared in this condition. This kind of product will keep about a month, and breaks to pieces after this period.

Dried sardines in the round (*Visayan, uga, binolad*).—Unlimited quantities of young and full-grown sardines are dried in the round. As soon as the fish arrive in the salting plants, they are dumped into the brine vats or tanks, where they are kept in brine or blood pickle until the next day when they are taken to dry on the banata.

Young sardines, which are very small and do not contain as much feed and fat as the full-grown ones, are sufficiently cured in one night and result in a far superior product if properly prepared. The full-grown fish undergo partial putrefaction during the curing, and when exposed to the sunshine swell due to the gas formed, and to the air in the intestines and air bladder trying to escape, oftentimes resulting in broken bellies.

Broiled sardines (*Visayan, inasal*).—Some local dealers with very limited capital put up broiled sardines each season. Full-grown sardines, which are chiefly used, are washed and soaked in brine for an hour or two to give the desired flavor. A number of sardines are then held together between two flat bamboo sticks, each fish having a piece of the coco-leaf stem thrust through its body to keep it from breaking. The fish are next placed above a red-hot bachao fire to cook. The cooked fish do not keep long and are consumed mostly in Iloilo and Capiz Provinces.

MACKEREL CURED IN VARIOUS WAYS

Dried split mackerel (*Visayan, pinakas*).—After the fish are received in the salting plant, they are immediately dressed. The splitter with his left hand takes the fish around the center of the body, with the tail towards him and splits it down the back on the left side of the backbone from the neck to the tail, and by letting the fish lie on its throat the head is split, so that the fish lies open and flat after the viscera are removed. In salting, the split mackerel, after being rinsed in sea water, are placed in a tank containing a strong brine solution. Here they remain until the next morning when they are dipped out and washed again in sea water preparatory to drying. It takes but two days of good bright sunshine to dry the fish thoroughly. The dried mackerel are sorted into several grades, according to size, and packed in large baskets for shipment.

In some instances instead of being cured in brine the split fish are rubbed with salt on the flesh side only and packed in lots of five fish with the skin down in large baskets. The rest of the procedure remains the same as given above.

Kench-cured or dry-salted mackerel (*Visayan, binoro*).—The fish are prepared for salting by making a deep cut down the back through the body cavity from the nape to a little behind the dorsal fin, the sides being held together by the belly and the unsplit head. The viscera and the gills are removed, and having been washed in sea water the fish are soaked for two or three

hours in strong salt pickle. The brined fish are dipped from the vat, their bellies are filled with salt, and they are packed in rows on their sides in large bamboo baskets with salt spread on each layer.

Pickle-cured mackerel (*Visayan, tinabal*).—The process consists simply in dressing and cleaning the fish and filling the belly with salt as for kench curing. The fish are packed in a similar manner in petroleum or gasoline cans, the tops of which are soldered after two or three days.

Dried round mackerel (*Visayan, uga, binolad*).—In preparing dried mackerel only young fish are used. The fish are gutted but not split, and brined for one whole night. The following morning they are taken out to dry in the sun.

Broiled mackerel and mackerel cooked in vinegar.—The processes in preparing these products from mackerel are similar to those already described for sardines.

DRIED SPLIT TANGUINGUE, PAMPANO, SNAPPER, ETC. (VISAYAN, PINAKAS)

Other fishes of considerable size are put up like the mackerel as a dried split product. If they are too large, another split is made between the backbone and the other side of the fish from the inside outwardly, and several cuts are made on each of the flesh portions. From twelve to twenty-four hours are required to cure large-sized fish. The fish are taken out, washed in salt water, and dried in the sunshine on bamboo flakes, with no addition of salt.

SLICED TANGUINGUE (VISAYAN, GUINOLOT)

Tanguingue are often cut into slices, each 1.8 centimeters thick. The slices are brined overnight preparatory to drying the next day or are rubbed with dry salt on both sides and packed in petroleum and gasoline cans for pickle curing. The heads are split and cured with the rest of the fish.

FAULTS NOTICEABLE IN THE PRESENT CURING PROCESSES AT ESTANCIA

Estancia is a very small municipality with many of its houses located at the edge of the seashore. Its population increases during the sardine season when many fishermen, merchants, and laborers from other localities live there temporarily. It has no adequate means of disposing of sewage. The municipality has not enough fresh water with which to clean the interior of the salting sheds; such as, the concrete floors, the brining

tanks and vats, the drying platforms outside, and a number of other things employed in the preparation of fish products. Large-sized fish, like mackerel and pampano, after being split, are washed in the black turbid sea water and all their viscera and contents are dumped there as a matter of course. Condemned fish, which have been spoiled by rain, infected with fly larvæ, or improperly cured, are disposed of in like manner. Sardines are washed in the same sea water before being taken to the salting sheds for brining.

Inside the salting sheds the conditions are far from satisfactory. The vats and tanks are filthy in the extreme and are seldom cleaned. They contain brine, which is used over and over, weakened by the blood and the water coming from the fish. It is not changed but kept strong by the addition of fresh salt now and then, until it is perpetually a filthy, stinking, semiputrid liquid, which probably in many cases does the fish more harm than good. Here and there busy, barefooted laborers are seen working with the fish and walking in the brine. Brine, coming from already prepared fish in the baskets and from the salting floors, finds its way into the tanks and is used to do the preliminary pickling of other batches of fish.

Fish to dry are sometimes placed in woven bamboo splits and matting which are laid close to the ground over pieces of bamboo stems. As a result, the fish often contain particles of dirt and sand.

EXPERIMENTS ON BRINE, PICKLE, AND KENCH CURING OF SARDINES

FACTORS HINDERING EFFECTIVE CURING

Before a start was made in preserving fish, it was evident that certain factors would to some extent handicap the bringing out of the desired improvements. The most important among such factors are the impure condition of the native salt, the extreme humidity of the atmosphere, and the warm climate.

IMPURITY OF NATIVE SALT

Salt produced in the Islands contains a higher percentage of calcium chloride, magnesium chloride, and other foreign chemical substances than the American salt used for salting fish. In addition to such impurities there is a greater percentage of insoluble matter present in the native salt; such as, small pieces of broken earthenware, brick, wood, and straw, and particles of sand. By a great number of experiments it has been found that the common impurities in salt (calcium, magnesium, and

sulphates), even in small quantities, retard the penetration of sodium chloride; so much so that in warm weather the fish may spoil before the salt strikes through. Furthermore, a difference in the physical aspect of the product has been noticed due to the effects of pure and impure salts. The flesh of the fish cured by the impure salt is white, opaque or chalky in appearance, and much harder and firmer in consistency; that of the fish salted with fine salt is translucent, somewhat yellowish, and much softer. Although the white and hard product is preferred in the market, the yellowish and soft kind is far superior because of the fact that the former has retained the calcium and magnesium, giving to it an acrid taste which is undesirable.

The domestic salt is prepared chiefly by solar evaporation. Such salt is known to be infected with microörganisms which cause the reddening of salted fish products. The red discoloration is notably present on the split, lean fish after a short time. The microörganisms are of two kinds—a spirochæte, which in colonies is pale pink, and a bacillus, whose colonies are deep red. These microörganisms are said to live and grow either on moist salt or very strong salt solutions.

EXTREME HUMIDITY OF THE ATMOSPHERE

In localities where there is extreme humidity, fish preserved by means of salt, particularly by the kench and drying methods, readily absorb moisture from the air, undoubtedly due to the presence of salt in the product. As is well known, moisture in the fish is favorable for the development of bacteria, molds, and fungi, and an abundant growth of these organisms can be expected even on heavily salted products. The preservative action of salt is reduced to some extent, because on contact with moisture it dissolves and drains away from the fish.

WARM CLIMATE

In a warm climate, where conditions are unsatisfactory at best, fish cannot be left standing long untreated. Decomposition soon takes place. Sometimes fish become putrid before the salt penetrates into the flesh. This is especially true in curing fish in the round, fish with closely set scales, and fish containing a great amount of feed and fat. Full-grown sardines, prepared in the round as binoro, become partially spoiled during the curing process. The delay in transporting fish to the salting plants from the fish corals often results in stale fish. Decomposition also takes place during transportation due to "heat-

ing" occurring in great piles of fish in large sailing boats, or *praos*.

SUPPLIES FOR EXPERIMENTS

For the following experiments, fresh, full-grown sardines were used. Good results were obtained in using fine ground Ilocano salt, since it served the purposes for the different processes employed. A salinometer was used, and although it is applicable only to conditions at 15.66° C. (60° F.) it served to indicate the percentage of saturation of the brine solutions prepared. In connection with its use, a graduate was found to be serviceable. Empty Japanese wooden kits for soyo-bean sauce were used as containers.

MODES OF PROCEDURES

Before being cured the fish were given a thorough washing in sea water to remove the dirt and slime from their bodies, and the scales were left on. They were next placed in saturated brine for two hours to harden and to get rid of the blood. Since the fish were of nearly uniform size, the process of grading was eliminated. Three series of experiments were performed simultaneously, and for each series three curing processes were used. To make direct comparisons, the sardines were equally distributed into lots, each of which contained one hundred fish to be treated under each curing process of each series. The sardines were prepared in two ways—beheaded and gutted, and in the round.

A highly concentrated brine solution was prepared for brine curing in wooden kits by mixing Ilocano salt in fresh water until no more of it could be dissolved. Sardines to be cured by the brine method were placed in the solution without special manner of arrangement, with sufficient salt added to the top to keep it saturated and until the amount used was equal to one-half the bulk of the fish. For the kench and pickle-curing methods, dry salt in the same proportion had been set aside. With some salt spread at the bottom of the kits, the sardines were laid down with the bellies up, slightly on a slant and the different layers at right angles with each other as in the Norwegian cure. Each layer was well covered with salt, and the top layer had a good pile of it. Several half-inch holes had been drilled at the bottom of the kits for kench curing, the purpose being to allow the pickle formed by the fish to run out. In the other cure, the pickle was retained in the container to salt the fish. Sufficient weights were placed on boards over the

brine- and pickle-cured fish, so as to keep them submerged in the liquor. The different lots were kept standing in the same room, and now and then observations were made.

EXPERIMENTS A

The three lots of fish in this series of experiments were cured in the round. The dry salt, converted into saturated brine solution for the brine cure and also used for the curing of sardines by the kench and pickle-curing methods, contained saltpeter in the proportion of one to ten of salt, which is equivalent to one of saltpeter to twenty of fish by volume. Saltpeter was used to determine what preservative action it has on the fish. On examination at the end of twenty days, the sardines kept in the strong brine were partly decomposed in the region of the backbone, the flesh was soft and reddish, and the skin was a little rusty. Sardines, dry-salted, with the pickle run out, were stiff and hard, but the flesh next to the backbone was rusty due to the oxidation of fats. The cured fish had a shriveled appearance, being thin and dry. The flesh was reddish and the skin exceedingly rusty. Fish held in their own pickle were still firmer than those in the first two cures, with the red color of the fish well retained. The viscera were not struck; and the flesh, although properly cured, was a little soft. A slight rusty color was noticed on the surfaces of the fish.

EXPERIMENTS B

Fish used for these experiments were beheaded and gutted, the viscera coming out with the removal of the head by a side stroke of the knife. Saltpeter in the same proportion as above was used for the three cures. Brine-salted sardines were found hard after nearly twenty days curing, with the flesh very slightly reddish and well cured. A bitter taste of the flesh was noticeable. Those kench cured were also firm but with putrefaction and rustiness in the region of the backbone. The skin surfaces were discolored with rust. In pickle-cured fish the flesh was well struck by salt and slightly pale in appearance. The skin was absolutely white and looked fresh. Although the fish had a bitter taste, they were in excellent shape as far as the curing was concerned.

EXPERIMENTS C

As in experiments B, the sardines used were beheaded and gutted. No saltpeter was employed. It appeared that the fish surrounded constantly with saturated brine were fairly well

cured after twenty days, with the flesh pale. The fish were spread out in the sun to dry and resulted in a fine product. A second lot prepared by the kench-curing method, although firm and hard, were found to be rusty inside the body next to the backbone. The skin was also rusty. The fish on the whole were not in fine shape. The pickle-cured fish were in excellent shape, with the flesh firm and pale, with no evidence of rusty discoloration in the flesh or on the skin surfaces. The scales retained their brilliant silvery color.

CHANGES NOTED IN THE EXPERIMENTS

The fish prepared by the brine method in the three series were soft and contained much water. This is due to the fact that the brine became weakened by the moisture coming from the fish and the extraction of water stopped sooner than in either of the other curing methods. The fish, moreover, acquired a peculiar rather unpleasant odor and had a bleached appearance. A good number of fish prepared in the round by the brine method had their bellies breaking away. It appeared that in the kench curing there was more shrinkage and shriveling and the natural color of the fish was retained. The fish, being exposed to the air, became "rusty." Rusting was due to the oxidation of the oil present in the fish, giving them a dark brown color. This condition was not much noticed on the fish surrounded with brine and pickle. There was more of the discoloration in sardines in the round, the reason being that the fatty contents of the fish were not removed. A red color in the fish is preserved by the use of saltpeter, which acts on the red substance of the blood. The red color was noticed to be much less in the cleaned fish than in the fish cured in the round, because the blood had more chance to escape. Although saltpeter neutralizes the unpleasant hydrogen sulphides, it is not known to possess an inherent preservative action. It was apparent that the third series of experiments gave better results. The pickle-cured fish particularly were in excellent shape. They had a distinctly pleasant flavor. They were much better cured than those salted by the brine process, being surrounded all the time by saturated pickle. There was no evidence of rustiness on the surfaces of the fish, the brilliant silvery color of the scales being retained. Those prepared by the kench method were just as firm and hard, but were found to be discolored with rust inside and on the skin. The pickle-cured sardines were slightly dried in the sun-

shine, resulting in a product which could be considered an improvement on the binoro.

CONCLUSION

There is no doubt that the use of salt alone in preserving fish is an excellent method. What is needed is the scientific study of the problems and principles connected with its application, especially in this country where they are not understood. Various chemical agents have been used with salt in other countries but with no apparent advantages produced. In the foregoing experiments saltpeter was employed. The use of saltpeter and other chemicals in this country would be not only expensive, but also dangerous to the health of the consumer considering the lack of knowledge of the properties of such chemicals on the part of those engaged in fish preservation.

FURTHER EXPERIMENTAL WORK

KIPPERED TANGUINGUE, LAPO-LAPO, AND PAMPANO

Six tanguingue were split into halves by making cuts along the back from the head to the tail on each side of the backbone, and through the throat, the belly, and each side of the anal fin. The split heads were cut off at about the end of the first vertebra, the entrails removed, and the already-cut kidneys scraped off. The blood was carefully washed off and the lining of the body cavity taken out. Each half of the fish was divided into two portions by making a longitudinal cut along the middle, through the black meat. To give the flesh the desired salt flavor, the cut pieces were immersed in a saturated salt solution for three hours. They were next soaked in clean fresh water for about fifteen minutes, the purpose being to remove any excess salt settling on the surfaces of the fish. The cut pieces were then fastened by means of hooks to the sticks from which they were suspended in the smokehouse. The tanguingue were allowed to drain in the smokehouse for an hour or two; then fire was kindled on the floor below the fish from guijo sawdust to produce smoke until the temperature became 60° C. (140° F.). The heat was maintained at this temperature for twenty-four hours, and the smoked product although satisfactory was discovered to be very slightly soft inside. This condition was due mainly to the delay in producing the required heat at the start.

On the third day the same experiment was repeated, using five medium-sized tanguingue. Care was taken that the required heat of 60° C. (140° F.) and an abundance of smoke were produced before the fish were hung in the smokehouse. The resulting product was found satisfactory in every respect. It is, however, a perishable product and will not keep long unless it is put in cold storage or canned. It was firm throughout, and had a uniform dark brown color. Samples of the fish were distributed in Iloilo and given to visitors coming to the experimental shack.

Lapo-lapo and pampano, prepared in the manner described above, were pronounced excellent by those who had tried them.

During the fiesta at Estancia, some samples were served to visitors. A number of prominent people from Capiz and Iloilo took away some with them. Two kippered tanguingue I brought to Manila on August 22 were well received.

HARD-SMOKED PAMPANO

Four split pampano, which were salted in their own pickle for three days, were freshened in water for one night. They were then drained for a few hours and hung on wooden rods, which were placed in the smokehouse. An abundant smoke was produced from guijo sawdust in a fire box located a few feet from the bottom of the wooden smokehouse. The smoke generated in the oven passed into the inclined flue and then into the chamber where the fish were hung. The temperature in the smokehouse was observed to be about 35° C. (95° F.). Smoking continued for three days, after which time the fish became hard. They were taken from the smokehouse and hung for observation. An abundant growth of mold was found on the smoked product at the end of thirty-five days.

Thirty-five mackerel, which were split and gutted, were brined for an hour, immersed for four hours in spiced vinegar, and given a hot smoke for twelve hours. After the smoking process, the fish became very hard. Samples kept under observation were slightly infected with mold after three weeks, although they were still in good condition. Ten days afterwards the fish were found exceedingly moldy.

DRY-PRESSED SALTED SARDINES

An attempt to produce dry-pressed salted sardines similar to the salachini product of Monterey was made, and the fish were prepared for curing in the following manner. The sardines,

received very early in the morning in absolutely fresh condition, were salted round. Fine ground Ilocano salt was used, one part of salt to two parts of fish by volume. The salt was applied dry; some of it was spread at the bottom of a concrete tank and on each layer of fish, and a considerably larger amount was placed on the top layer. It was expected to let the fish remain in the pickle they formed for two or three weeks, but the third day it was found that the fish had undergone decomposition before the salt had a chance to strike through. On account of the gas formation resulting from decomposition, the fish became swollen and were floating on the pickle. So much gas was formed that very heavy rocks placed on boards over the fish were necessary to keep them submerged. Another batch of fish was prepared in the same manner as above, using coarse Malabon salt, with the same unsatisfactory results.

From the above experience, it is readily seen that in the absence of gutting, even under the best of conditions such as cool atmosphere, strong fresh brine, and absolute cleanliness, it is difficult to salt the sardines thoroughly so as to arrest internal decomposition and get a satisfactory product. During the fishing season the sardines contain too much fat and feed, aside from possessing a swim bladder which is fully charged with air. It is not surprising, therefore, to find the local binoro prepared from round sardines a fermented product that will not keep longer than three months. Being kench-cured, the fish become rusty in a very short time, with the flesh becoming rancid to the taste and reduced to tiny pieces; and with the guts unremoved the belly breaks away, subjecting the fish to fly-larvæ infection.

Fresh, round sardines were kept in saturated brine for one night, and the following day they were taken out in the sunshine to dry. Care was taken that the fish were protected from the direct rays of the sun, letting the wind do most of the drying. It was observed, however, that the sardines while still in the tank became partly spoiled and on exposure to even subdued sunshine swelled up, and in many cases their bellies became ruptured. It is said that this fermented product finds a ready market in Manila, but its condition will not insure its keeping long.

SPICED SARDINES

About one hundred sardines, after being split along the back next to the backbone from the head to the tail, were eviscerated and cleaned thoroughly in sea water. The split fish were then

rubbed on both sides with fine ground Ilocano salt. They were packed in a wooden kit, flesh side up, with a little salt sprinkled on each layer. After standing for two weeks, the fish were soaked in clean water overnight. The following morning they were repacked in an earthen pot in vinegar with spices which were prepared beforehand. The vinegar used was about sufficient to cover the fish in a gallon container, and contained various spices in the following proportions:

	Grams.
Black pepper	8.5
White pepper	6.8
Cayenne	6.8
Cloves	6.8
Sandal	6.8
Cinnamon	6.8
Ginger	4.5
Bay leaves	11.3
Spanish hops	5.7

The spiced pickle was prepared by cooking the spices in vinegar for about an hour. The pickle was strained to remove the spices and allowed to cool overnight. The spices were used the next day in packing the fish, and the pickle was used to fill the container. The sardines thus prepared became infected with bacteria and mold after two weeks.

Another batch of one hundred sardines was prepared for curing in the same way, but soaked in saturated brine for only two hours and then freshened in clean, fresh water for about ten minutes. The split fish were then packed in a tin can which was soldered up with fresh spiced vinegar, prepared in the same manner as above and the spices used of the same proportion. After one month the fish were examined and found to have an abundant growth of mold at the top layer. The product, however, was in a fine state of preservation. The fish were dried in the sun and used for food.

The two experiments given show that the presence of air in the containers was sufficient to spoil the product. It was necessary, therefore, to have the air exhausted, because no mold or bacterial growth could develop in a vacuum.

SMOKED SARDINES

Split sardines, soaked in saturated brine for two hours and cold smoked for thirty-six hours, kept very well for about a

month, after which mold developed gradually. In smoking, the fish were suspended by means of hooks from wooden sticks.

Sardines that were split and gutted were cured for two hours in a very strong salt solution containing raw mustard in the proportion of one part of mustard to twenty of salt. The fish were given a hot smoke at 60° C. (140° F.) for four hours, and then a cold smoke at 35° C. (95° F.) for two whole days. Molave sawdust was used to produce smoke. In a month samples set aside for observation contained but very little mold. Ten days later the smoked fish were almost wholly moldy.

Two hundred round sardines were brined for two hours to give the fish the necessary salt flavor. The fish were hung from wooden rods in the smokehouse and subjected to hot smoking at 60° C. (140° F.) for four hours and then to cold smoking at 35° C. (95° F.) for twenty-four hours. The fish became exceedingly moldy about two months following the smoking process.

Round sardines were brined for two hours, the brine containing one part of raw mustard to two of salt. The fish were then transferred to spiced vinegar, where they were held about two hours. At the end of this period, a hot smoke at 60° C. (140° F.) was applied to the fish for three hours, and a cold smoke at 35° C. (95° F.) for forty-eight hours. No mold was seen on the fish after one month, and only a slight growth was discovered two weeks later. In preparing the spiced vinegar, the spices—such as, the black and white pepper, ginger root, garlic, and cinnamon—were added to the boiling vinegar until they became soft. The spices were then strained out and the spiced vinegar allowed to cool overnight. About 28 grams of garlic were used with the other spices in the proportions already given for a gallon container. The smoked product had a pleasant flavor and met a favorable reception from those who tried it.

An attempt to dry in the sunshine round sardines which had been prepared for smoking resulted in an unsatisfactory product. The fish after being brined and cooked in boiling water were exposed to the sunshine for nearly six hours and soon after were given a cold smoking for thirty-six hours and a hot smoking for four hours. The drying outdoors afforded flies a chance to lay their eggs in the gills of the fish, and during the cold-smoking process maggots were seen crawling on the smoked product. This experiment indicates that it is essential to have the cooked fish smoked right after they have cooled down in the baskets.

The local method was used in smoking a few hundred sardines, with some new features introduced. The brining process remained the same, only that absolutely fresh brine was used in each instance. The cooking of the fish in boiling salt water or weak brine solution was adopted, but the drying process was eliminated. The boiled fish, after having cooled down in the baskets, were transferred into the trays, each of which held about two hundred sardines against sixty-five or seventy, the capacity of the basket locally used. The trays were 3 feet square, of galvanized-iron netting, and framed with tangili on all the four sides. The netting was square meshed, and the meshes were only 0.5 inch. There were seven such trays, and four or five more could be employed in order to bring the capacity of one of the experimental houses constructed to a little over two thousand sardines at one smoking. The fish were smoked at a temperature of not over 60° C. (140° F.), and the lowest tray was placed some 3 feet above the fire. The heat was regulated by means of a draft opening at the bottom and by small holes at the top for the smoke to escape. The fish could thus be prevented from becoming too dry and hard from too much heat. Guijo sawdust was used to produce smoke. The fish were left to themselves on the trays, becoming evenly dark brown after a few hours smoking, instead of being turned over as in local practice. Comparatively little sawdust was used for the number of fish smoked, as there was only one furnace used. The present method at Estancia calls for the use of one oven to smoke each basket of fish.

As a result of the innovations, a smoked product of the same kind as the local article was produced with the following advantages:

1. A great economy in floor space was effected in the use of a smokehouse of the type constructed for experimental work.

2. This smokehouse had a much greater capacity than any of those used locally, and by increasing its height a larger number of fish could be cured at one time.

3. Although the same length of time for smoking was employed, the quantity of sawdust consumed was comparatively much less.

4. The smokehouse was so constructed that different kinds and sizes of fish could be placed in its chamber for smoking.

5. An economy in labor was effected because fewer men were employed in the preparation of the smoked product.

6. The fish placed in the smokehouse required less attention, and the little handling to which they were subjected resulted in a more sanitary article.

HARD-SALTED TANGUINGUE AND PAMPANO

Fifteen medium-sized tanguingue were obtained for this method of curing, which is similar to that used for codfish. The fish were beheaded at about the end of the first vertebra and around the neck. They were split open along the back throughout the entire length, with about three-quarters of the backbone removed. After the removal of the viscera, blood, and lining of the body cavity, and the scraping off of the kidneys, the split fish were salted in a concrete tank with 9.8 kilograms of Ilocano salt to 12.25 kilograms of cleaned fish. The fish were piled in layers, with salt uniformly spread on each layer and at the bottom, and a pile of salt placed on the top. The fish and salt settled slowly and were soon covered by their own pickle. After about two weeks, it was found that the fish were well cured. They became hard and contained but very little water. The salted fish were washed with sea water and spread out in the sunshine to dry. In the afternoon they were taken indoors and laid in piles for the night, the idea being to let the moisture of the inside drain from the fish. This process, "water horsing," helped in the drying of the fish. The next day the partially dried fish were placed on flakes with the flesh side down for further drying. Early in the afternoon the tanguingue were turned, to let the flesh side dry. Care was taken that no direct rays of the sun struck the fish, the object being to let them dry slowly by means of subdued sunlight and wind. Four days were required to dry the fish thoroughly. The dried product was moderately hard and yellowish in color. Six fish were kept for observation and the rest sent to Iloilo and given to visitors. Three weeks following the drying process, there was observed a little pinkish color on the flesh side of the fish. More of the pinkish color was found after one month more. Now and then the fish became moist.

The experiment was tried on the pampano, with practically the same results. Several fish purposely kept in their own pickle for a month and a half were well covered with pinkish color on

their surfaces. After a thorough washing in clean sea water, the fish were found still to be in good shape.

SUGGESTIONS FOR IMPROVEMENTS

ABSOLUTE FRESHNESS AND CAREFUL HANDLING OF FISH BEFORE SALTING

To effect a thorough curing, the fish must be absolutely fresh before salting. At Estancia chief reliance is placed on the sailing boats in transporting fish from the fish corals. Under unfavorable wind the sardines become stale before reaching the salting plants on account of very much delay. Rapid transportation is needed. Power boats can be employed in towing loaded boats to Estancia and in relieving the fishermen of the difficulty in disposing of the extraordinarily large catches in fish corals, where fish in many cases are found dead from congestion. The local fishermen should realize that the success of the Japanese fishermen in Manila Bay is due mainly to the adequate provision for the prompt delivery of fish to Manila markets.

It is essential also that the fish be carefully handled before salting. Bruises on the body of the fish promote decomposition and result in an inferior product. Therefore, fish should not be walked on or squeezed in the nets when being hauled from the fish corals into the boats. They should not be thrown roughly into the boats or into the vats and tanks. Fish should not be piled too deep in the hold of large sailing boats, as heating occurs in large masses of fish and this hastens decomposition. It is best not to let the fish be exposed to the direct rays of the sun, but have sea water poured over them now and then.

THOROUGH CLEANING OF FISH

Not all kinds of fish require the same treatment in curing, and some are more difficult to cure than others. Fat fish and fish containing much feed are apt to spoil rapidly, and those that possess air bladders are liable to rapid deterioration. The viscera, milt, roe, and blood decompose rapidly, and it is necessary, therefore, to have them removed as quickly as possible. In the case of large-sized sardines abundantly caught at Estancia, which contain much fat and feed, there is no choice but to behead the fish, the viscera coming out with the head with a side stroke of the knife. Mackerels should be split and laid open, with attention paid to the removal of the air bladder which

quickly becomes inflated with gas and from which decomposition starts. Greater attention should be paid to the sanitation and cleanliness of the places where salted and dried fish are prepared. The tubs and the tanks, in which the preliminary pickling of the fish takes place, should be thoroughly cleaned out often. The brine should be as fresh as possible; the best is prepared directly from clean sea water and dry salt. Heads and guts should be utilized as a by-product, and if there is no way of using them for the present they should be buried in the ground or thrown away very far from the seashore.

SALT OF A HIGH DEGREE OF PURITY

A better product would be obtained by the use of a salt with less calcium and magnesium salts. The domestic salt produced by the old Filipino method is said to possess superior qualities for curing fish, but even at that, it is not as pure as the American salt used for the same purpose. If it can be retained considerably longer in storage, there is no question that it will have a higher degree of purity. Purity does not mean whiteness or cleaness, but the absence or rather the scarcity of foreign substances in the salt. The percentage of sodium chloride should be as high as possible, 99 per cent or over. The purer the salt is, the better it preserves the fish. The presence of calcium and magnesium, even in small quantities, greatly hinders the penetrating action of salt, and in a warm climate the fish may spoil before the salt strikes through. This is especially true in the case of the sardines prepared chiefly in the round as binoro, which is nothing but a partially fermented product. As has been stated, both calcium and magnesium are undesirable because they give an unpleasant acrid taste to the fish. Firmness and whiteness are not to be desired, because it is these impurities in the salt that give such qualities to the finished product.

SHIPPING AND STORAGE OF FISH IN BRINE

At present very little pickle curing is done at Estancia. Split mackerel and other large-sized fishes are slightly salted and dried in the sun for Iloilo, Capiz, and other markets. Binoro is a kench-cured product that is kept in dry salt all the time, with the pickle brine drained off. Unlimited quantities of young sardines and a few of the sipi are put up as a dried product.

None of these products, however, keep long, because being in contact with the atmosphere they rust and in time become rancid due to the oxidation of the fats. Sardines and mackerels are exceedingly fatty fish, and more of them should be put up in their original pickle or in fresh brine, with provision to exclude air which causes the fat to rust. In this country there is need for investigation of suitable cheap containers which can be used for pickle- and brine-cured fish. Petroleum or gasoline tin cans are used, but they rust easily; barrels can be obtained but not in large numbers and often at too high a price.

APPLICATION OF DRY SALT

It has been shown by experiments that a smaller quantity of decomposition develops when salt is applied dry than when brine is used. Furthermore, it has been found that salt employed in the dry condition penetrates the inside of the fish more rapidly. It is well understood also that the action of salt is to penetrate the fish and remove the water. The transfer of water from the fish to the outside depends on the fact that the water flows from the weaker to the more-concentrated solution (osmosis). When dry salt is brought in contact with fish, part of it dissolves in the outside moisture forming a strong brine solution, which tends to extract water from the fish. This water cannot weaken the outside brine solution (pickle), because there is always an excess of dry salt in the pickle which dissolves immediately and insures a saturated pickle all the time. If a salt solution (brine) is employed some of it enters the body of the fish. The result is that there is less salt on the surface of the fish to extract water from the inside. Since salt is used to remove water from the fish, it is evident that with dry-salt curing there is more rapid penetration and less decomposition of fish, and it is possible to preserve fish at a higher temperature.

CURING FISH UNDER LOW TEMPERATURES

It has long been recognized that low temperatures arrest the processes of decay; and the application of refrigeration, to enable salt to penetrate into the fish while it is still in a fresh condition, would not only result in effective curing but also help towards improving the quality of the product. The curing of fish by salt has not been much of a problem in cold climates, and the use of reduced temperatures should therefore be attempted

for commercial fish salting in a climate where the temperature averages well above 21.11° C. (70° F.). The curing may be done with a cold-storage plant or by icing alone. During the process of curing, the fish should be kept in a closed room where the temperature may be kept at not over 7.22° C. (45° F.) the proper temperature depending most on the kind and size of fish. The brining tank and containers should be located in the cold-storage room. For the mild curing of salmon in California 3.89° C. (39° F.) is considered the best temperature. Lower temperatures are also used. The brine of the tank should be iced down to the temperature of the room, and the iced brine should be saturated.

FISH PRODUCTS PREPARED AND TAKEN TO MANILA

Eighty-five mackerel were split, carefully dressed, and thoroughly cleaned in sea water. They were then given a coating of salt on either side and placed in a wooden kit in layers, with a pile of salt placed at the top and a little sprinkled on each layer and at the bottom of the container. The fish were left to stand in their own pickle for nearly ten days, after which period they were repacked in a new kit with fresh saturated brine added. The container was sealed up tight and shipped to Manila for study in the laboratory.

About three hundred of the young sardines were brined first for two hours, then pickle cured in Ilocano salt, two parts of salt to five of fish. In two months the fish had developed a fine flavor. They were packed in Mason jars, some of which were given away in Iloilo and the rest taken to Manila for distribution.

Following the method employed in the preparation of the improved binoro, nearly five thousand sardines were put up at different times preparatory to taking them to Manila. The fish were brined for two hours, beheaded and gutted, and arranged in layers in kits according to the Norwegian method, with salt placed at the bottom and on each layer of fish, and a pile on top. In previous experiments much salt had not been dissolved, so in this particular case one part of salt to three of fish was used. Some of the product was given away in Iloilo, and the rest taken to Manila. The binoro as prepared was a clean, sanitary article which would keep indefinitely. It was served to hotel guests and on the tables of a number of prominent Filipinos, and it was pronounced to be of superior quality.

Runs of sardines at Estancia during the 1927 season.

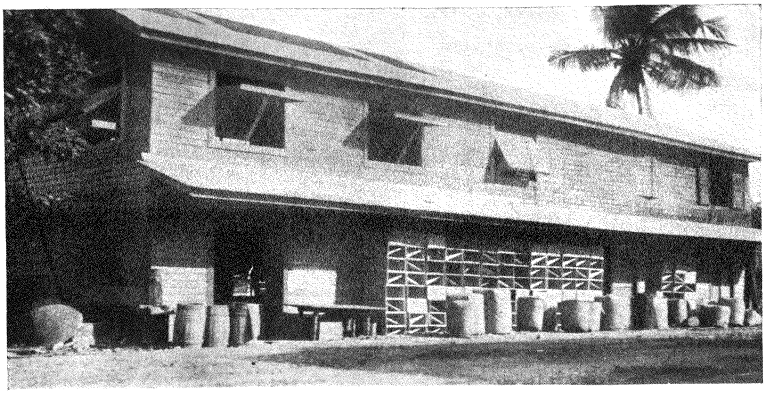
Date.	Fish.		Weather.
	Kind.	Quantity.	
April 25 to May 18	Young sardines	Plentiful	Fine.
	Full-grown sardines	Catches large but irregular.	
May 19 to June 1	Young sardines	Small	Do.
	Full-grown sardines	Catches large but irregular.	
June 2 to June 24	Full-grown sardines only.	Catches very large and runs regular.	Do.
June 25 to July 8	Engrenel [a] only	Small	Unsettled.
July 9	Full-grown sardines only.	Large catches	Fine.
July 10	do	do	Do.
July 11	do	do	Choppy sea, windy and cloudy.
July 12	do	do	Do.
July 13	No fish		Do.
July 14	do		Do.
July 15	do		Do.
July 16	Engrenel only	Large catches	Do.
July 17	do	Small catches	Do.
July 18	Young and full-grown sardines.	do	Do.
July 19	Engrenel only	do	Do.
July 20	do	do	Do.
July 21	do	do	Do.
July 22	Young and full-grown sardines	Very large catches.	Do.
July 23	do	do	Do.
July 24	do	Small catches	Do.
July 25	Young sardines only.	do	Do.
July 26	Young sardines	Large catches	Do.
	Full-grown sardines	Small catches	
July 27	Young sardines	do	Do.
July 28	Young and full-grown sardines	do	Do.
July 29	Engrenel only	Very small	Do.
July 30	do	do	Do.
July 31	do	do	Unsettled.
August 1	do	do	Fine.
August 2	Young sardines	do	Do.
	Full-grown sardines	Very large catches.	
August 3	do	do	Do.
August 4	do	do	Do.
August 5	Engrenel	Very small	Rough sea, rainy, very strong southwest winds.
	Mackerel	Very large catches.	

[a] A mixture of young sardines of three or four species, full-grown sardines, young Carangidæ, Leiognathidæ, Theraponidæ, etc.

Runs of sardines at Estancia during the 1927 season—Continued.

Date.	Fish.		Weather.
	Kind.	Quantity.	
August 6	No fish		Rough sea, rainy, very strong southwest wind.
August 7	do		Do.
August 8	do		Do.
August 9	Young and full-grown sardines. Pampano	Very large catches.	Fine.
August 10	Full-grown sardines only	do	Fine, but sea choppy.
August 11	Young sardines	Very small	Fine.
	Full-grown sardines	Very large catches.	
August 12	do	do	Do.
August 13	Young and full-grown sardines.	do	Do.
August 14	do	do	Do.
August 15	do	do	Do.
August 16	do	Small catches	Do.
August 17	do	do	Do.
August 18	No fish		Do.
August 19	do		Unsettled, strong winds, rough sea.
August 20	Engrenel only	Small catches	Do.
August 21	No fish		Fine.
August 22 to 30	Engrenel only	Small catches	Do.
August 31 to September 7	Young and full-grown sardines.	Very large catches.	Do.
September 8 to 12	do	Small catches	Do.
September 13	No fish		Do.
September 14	do		Do.
September 15 to 23	Young and full-grown sardines.	Very large catches.	Do.
September 24	do	Small catches	Unsettled.
September 25	do	do	Fine.
September 26	do	do	Do.
September 27	do	do	Do.
September 28 to October 2	do	Very large catches.	Do.
October 3	do	do	Unsettled.
October 4	do	Very small catches.	Rough sea and strong wind.
October 5	No fish		Terrific storm, torrential rains, variable winds, and very rough sea.
October 6	All fish corals destroyed.		Unsettled.
October 7	Vast schools of sardines reported in the sea.		Fine.
October 8 to 11			Unsettled.

ILLUSTRATIONS



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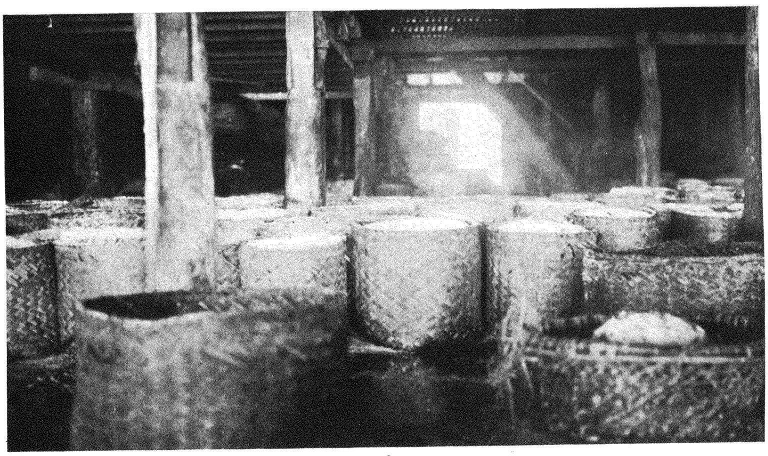

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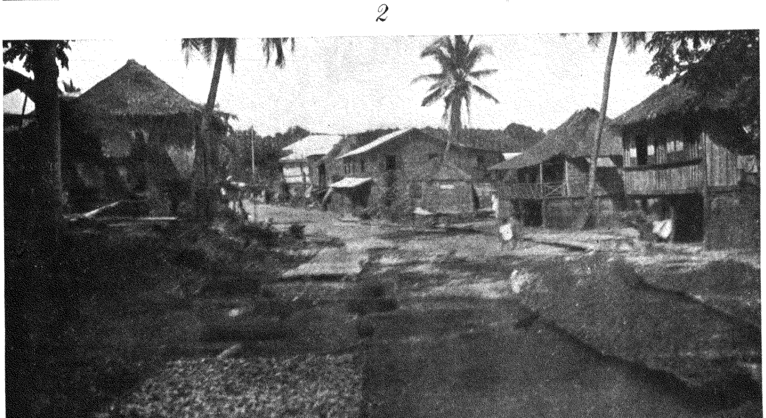

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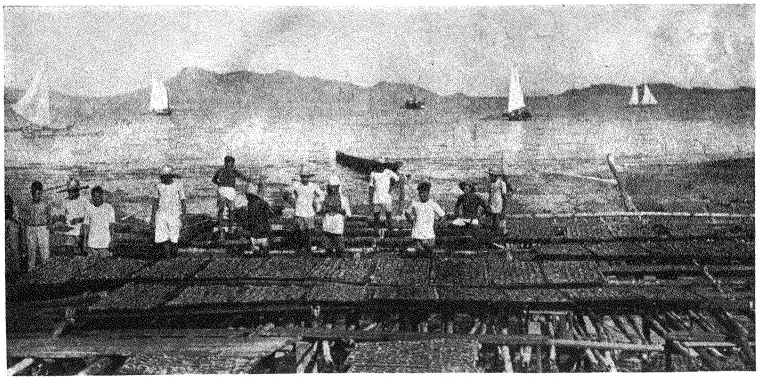

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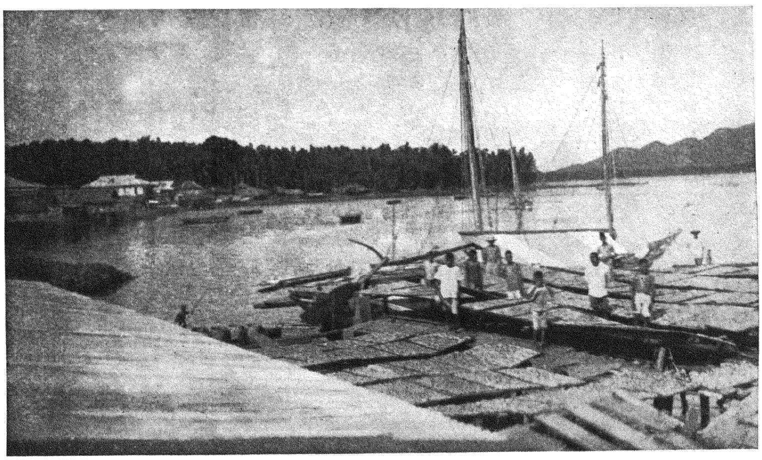

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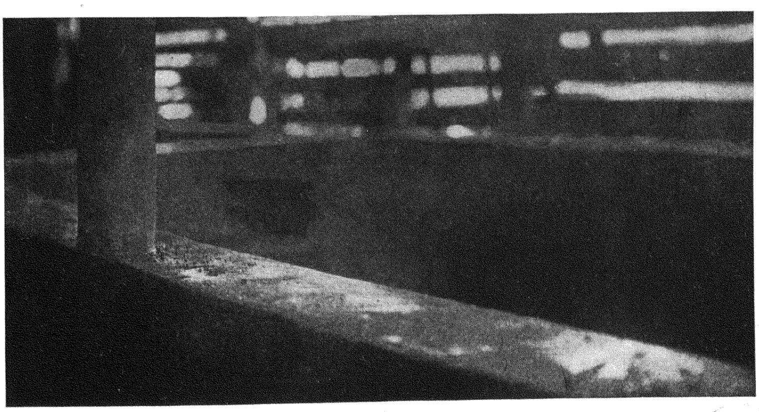

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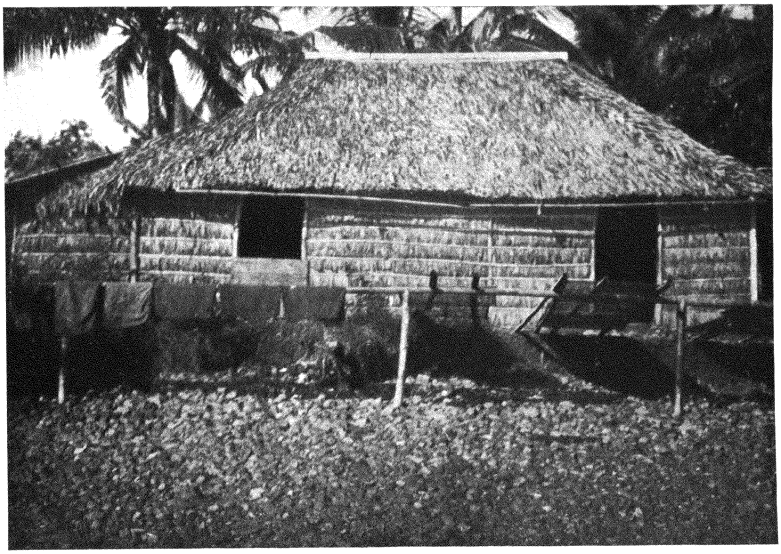

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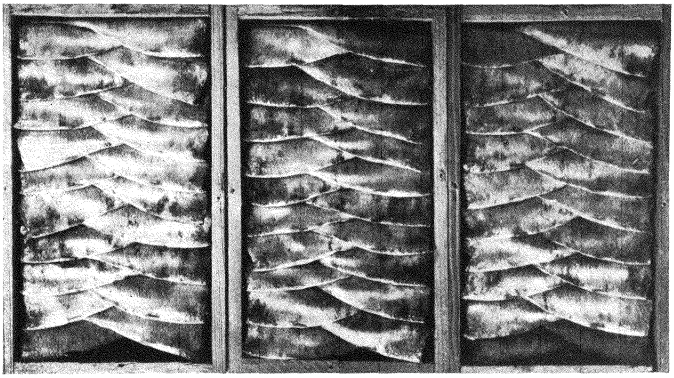

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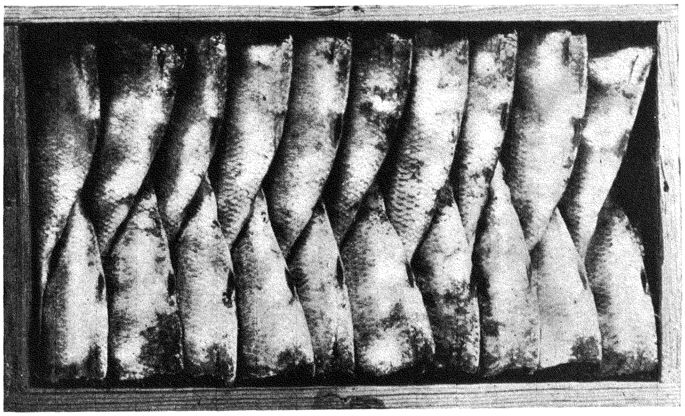

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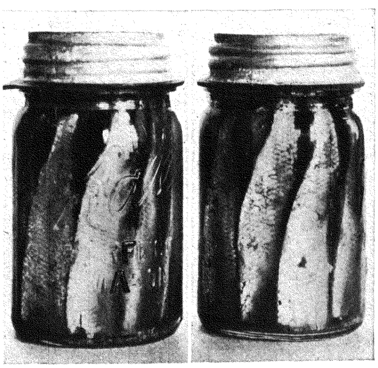

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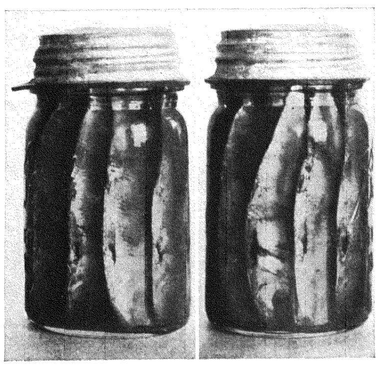

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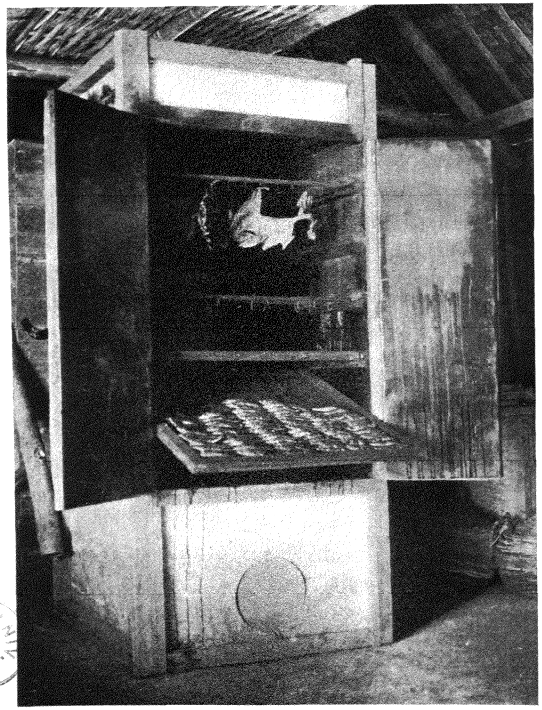

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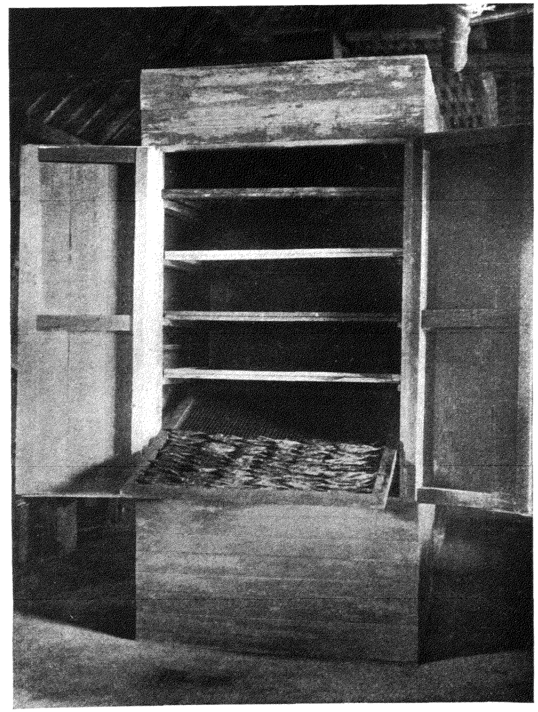

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PLATE 5.

OBSERVATIONS ON EQUINE DHOBIE ITCH OF THE PHILIPPINES [1]

By Francois H. K. Reynolds

Captain, Veterinary Corps, United States Army

James Stevens Simmons

Major, Medical Corps, United States Army

and

Joe H. St. John

Major, Medical Corps, United States Army

FOUR PLATES

The skin infection locally known as dhobie itch is an annoying and relatively important disease of horses and mules in the Philippine Islands. While the incidence has not been alarming, this condition has occurred in Army animals during the past thirty years, and in some has been responsible for long periods of uselessness. Occasionally it has become necessary to destroy the animal. The report of the Surgeon General, United States Army, for 1928, records eighty-four cases of dhobie itch among animals belonging to the Philippine Department. Fifty-three of these were horses and thirty-one mules. The noneffective rates of 5.79 and 2.95 for dhobie itch that year indicate that this condition was responsible for a considerable part of the total rates of 38.28 and 22.54, respectively, for all diseases. Dhobie itch caused the loss of five thousand six hundred thirteen days to the service during 1928; while in spite of prolonged treatment nine horses and two mules became so affected by the disease that they were condemned as useless and destroyed.

Clinical signs.—In the Philippines equine dhobie itch is a chronic or subacute infection of mules and horses, characterized primarily by the development of hard subcutaneous nodules which vary from minute and barely palpable lesions to others about 2 centimeters in diameter. After several days there ap-

[1] From the United States Army Medical Department Research Board, Bureau of Science, Manila, P. I.

pears on the apex of the nodule a serous exudate which glues the hair together and dries in the form of a grayish scaly crust. The lesions may coalesce, forming large areas 5 to 20 centimeters in diameter; and the crusts and hair often become detached, leaving exposed patches showing various degrees of inflammatory reaction. When the crusts of the lesions are removed early, the underlying exposed surface is moist, red, and usually perforated by minute openings from which a clear yellowish fluid may be expressed. In the severer cases these processes extend over large areas, involve the deeper layers of the skin, and are usually attended by suppuration. Certain cases may assume the appearance of furunculosis. Secondary infection with pyogenic bacteria almost invariably occurs and assists in prolonging the disease. The lesions may be distributed over the head, face and neck, and back. During the disease the temperature may or may not be elevated and in chronic infections the animal presents a dejected appearance.

Etiology.—Horses with thin skins are particularly susceptible to dhobie itch. The disease is most apt to occur during the hot, rainy season, although it may also occur during the dry season. One attack does not produce immunity; as a case apparently cured may again acquire the infection. For many years it was believed that the condition might be due to infection with a trichophyton; however, no experimental evidence has been presented to substantiate this assumption. The absence of positive evidence during the past and the negative findings reported below tend to disprove the prevailing opinion.

PRESENT INVESTIGATION

In this investigation two hundred twenty-one specimens, collected during a period of six months from different lesions on various animals, were examined in the following manner:

Microscopic and cultural examination of lesions.—Superficial and deep skin scrapings, scabs and the roots of hairs from dhobie-itch lesions were collected and examined for microörganisms. The tissues were removed and macerated in chloroform for one to twenty hours to remove the fat. Then the material was centrifugalized, the chloroform discarded, and the remaining sediment placed on a glass slide. After the addition of a few drops of 10 per cent sodium hydroxide and warming gently, the specimen was examined microscopically. All of the two hundred twenty-one microscopic preparations were free from trychophyton or other fungi.

After cleansing the scabs and surrounding skin with alcohol, material for culture was collected by lifting the edge of a scab with sterile forceps and rubbing the inflamed surface underneath with a sterile platinum wire. In some instances hair roots for culture were taken directly from lesions, and in others they were first treated for five minutes with 10 per cent sodium hydroxide and washed with sterile distilled water. Cultures were made of the various materials on Sabaraud's medium and blood agar.

The results of this series of microscopic examinations and cultures show that all of the materials contained staphylococci, the majority of which were *Staphylococcus albus,* with a smaller percentage of *S. aureus* and *S. citreus.* All of the specimens were free from evidence of trichophyton or other organisms of this kind. These negative results and the observations recorded below prove that the disease is not a trichophytosis but is due to some other cause.

During the study just mentioned, several significant facts were observed which suggested the possibility that the disease might have been produced in some way by insects. For example, one case, a dejected-looking mule covered from head to tail with chronic dhobie-itch lesions of long duration, referred for examination by Major D. B. Leninger, V. C., was placed in a screened stall as a general prophylactic procedure. In order to make a careful study of the lesions, medication and grooming of the animal were discontinued. Contrary to the usual course of this infection the lesions did not persist, but within twelve days had healed; the skin became healthy and showed a beginning growth of new hair. Since the most probable factor connected with the cure of this case was the removal of the animal to a screened stall, it seemed reasonable to suspect that protection from biting insects might have played a part in the recovery.

Another occurrence which indicated the probability that the disease was not specific was observed among ponies kept at the Manila Polo Club. These animals which had been stabled on dry, cleared, windswept ground within a few hundred yards of Manila Bay were never troubled with dermatitis until the recent removal of the stables to a sheltered swampy area a few hundred yards away. Several cases of dhobie itch occurred within four days after this move, but after the surrounding swamp was drained and the brush removed these cases recovered.

Since these observations suggested that the disease might be conveyed by insects, experiments were made to test this theory

by (*a*) placing badly infected animals in screened stalls at night in order to observe any changes in their clinical condition; (*b*) collecting biting insects from animals at night; and (*c*) by attempts to produce the disease experimentally.

(*a*) *Effect of protection from insects.*—As shown in the following protocols, animals which had been treated unsuccessfully for dhobie itch for long periods of time recovered without further medication after they had been kept in screened stalls for a relatively short time.

Case 1.—Mule 251–W, Fort McKinley, severe dhobie itch of two months and thirteen days duration. Lesions on face, head, neck, shoulders, back, croup, and tail. General condition poor. Dejected appearance. Treated unsuccessfully and had been condemned. All medication and grooming were stopped and the animal was kept in a screened stall for twelve days, at the end of which time the lesions had disappeared and the skin had become normal in appearance.

Case 2.—Mule, Fort McKinley, a pronounced case, was placed in a screened stall and recovered without other treatment.

Case 3.—Mule, Fort McKinley, placed in a screened stall; recovered; returned to its organization where it became reinfected; was again placed in a screened stall and recovered.

Case 4.—Horse 24V2, Fort McKinley, has had repeated attacks since 1925. Was so covered with lesions and in such poor physical condition that it had been recommended for destruction just prior to screening. After two weeks in a screened stall, the case recovered. This animal suffered a recurrence in 1929, and was used as a control in the experiment embracing cases 7, 8, and 9.

Case 5.—Horse, Fort Stotsenburg. The screened stall method was employed in this case, and the following is an extract from a report by Captain K. E. Buffin, V. C.:

One horse, a black gelding, was admitted to the hospital with dhobie itch. This was a very severe case involving the head, neck, withers, shoulders, and back. Every known remedy was employed in the treatment of this animal but results were negative. The animal was placed in a screened stall where it remained completely protected from all biting insects, and at the expiration of ten days it had recovered sufficiently to be played in a polo game. Prior to this, the animal had been incapacitated for several months owing to the disease.

The only treatment this animal received while in isolation was daily grooming and the application of cocoanut oil to loosen the scabs.

At the expiration of ten days in the screened stall, the animal was sent to the polo stables but returned to the Veterinary Hospital each

evening where it was placed in the screened stall until the following morning. This was done for about two weeks, at the end of which time the lesions had healed and the animal showed no evidence of having had the disease.

[*Case 6.*—] Mule, Fort Stotsenburg, an old chronic case, was given the same treatment and made a similar response.

Cases 7, 8, and 9 were seen in October, 1929, at Fort McKinley. The first two were placed in screened stalls, while case 9 was kept unscreened as a control. Although this experiment was not completed because the animals were sold for food purposes, it was noted after twenty-one days that the condition of the screened animals had markedly improved while the disease in the control animal had progressed.

Case 7.—Horse 23V0 had multiple lesions as shown in the accompanying photograph. It was condemned in October, 1929, and screened November 2. At the time of sale, November 23, it showed marked improvement.

Case 8.—Horse 01V9 had numerous lesions, as shown by the accompanying photograph. It was condemned in October, 1929, and screened November 4. At the time of sale, November 25, it showed marked improvement.

Case 9.—Horse 24V2 (same as case 4) was affected as shown by the accompanying photograph. It was used as a control with cases 7 and 8, and was left unscreened. Lesions were more pronounced after the experiment than at the beginning.

The spontaneous cure of these cases of dhobie itch after a short period in screened stalls at night strongly suggests that biting insects are responsible for the disease and that such insects feed at night.

Collection of insects from animals.—Aided by a flash light several nights were spent in making careful searches for insects biting horses and mules. The most prevalent insects seen taking blood from the animals were *Culex* mosquitoes (*Culex quinquefasciatus*), although an occasional horn fly [*Haematobia* (*Lyperosia*) *exigua*] was also seen.

Attempts to produce the disease experimentally.—Since staphylococci were found in all of the dhobie-itch lesions examined, it was considered possible that these common skin organisms might have been carried into the deeper layers of the skin by insects during the act of biting, and that once injected they produced the typical low-grade infection. With this possibility in mind an experiment was performed in which areas of skin on four guinea pigs were shaved, painted with an emulsion of *Staphylococcus aureus, S. albus,* and *S. citreus,* and exposed to

the bites of ten normal *Aëdes ægypti.* During a period of three weeks' observation no skin lesions developed. It is possible, of course, that these negative results might have been due to the relative immunity of the guinea pigs to infection with the organisms used. However, negative results were also obtained in similar experiments with two horses at the Veterinary Hospital in Manila. From these experiments it is apparent that dhobie itch was not produced either in guinea pigs or horses when *A. ægypti* were allowed to feed on areas of skin heavily contaminated with the three species of staphylococci. The backs of four guinea pigs were shaved, then scarified, and into the latter was rubbed a mixture of scabs, skin scraping, and hair from primary and secondary lesions of horses. During three weeks' observation no lesions appeared.

Experiments with *Culex quinquefasciatus* proved unsatisfactory. Because of the difficulty of inducing the mosquitoes to feed in captivity, several lots of three hundred to five hundred *Culex* were liberated in a screened stall with a cured but susceptible horse (24V2), and buckets of water containing growing plants were hung in the stalls as mosquito breeding places. However, since the mosquitoes in each instance disappeared within a day or so and no engorged insects could be found, the fact that this horse remained free from skin lesions has little significance, and the possibility that *Culex* mosquitoes might play a part in producing dhobie itch remains questionable.

While these efforts to produce the disease experimentally with *Aëdes* and *Culex* mosquitoes were unsuccessful, the following experiment performed April, 1928, adds strong evidence to the theory that insects may be involved. An animal that had recovered from dhobie itch was fitted with a heavy canvas jacket which covered its withers, chest, and anterior half of the thorax, and was then released day and night on a small peninsula at Camp Nichols. Seven days later a few typical nodular lesions appeared on the exposed skin of the neck, while the skin covered by the jacket remained normal. Ten days later there were additional lesions on the neck, and after twenty-eight days the unprotected surface of the neck and back showed large numbers of typical nodular lesions. However, the areas of skin protected by the jacket remained free from infection.

Considering the results obtained in this last experiment together with the fact that the disease disappears when infected animals are kept at night in screened stalls, but remain infected if the stalls are unscreened, it would appear that some as yet

unknown night-biting insect or insects are primarily responsible for the condition. It is also believed that the open lesions may be produced by rubbing and biting during the animal's attempts to allay the itching and irritation produced by insects.

SUMMARY AND CONCLUSIONS

1. Equine dhobie itch has been known as an important incapacitating skin disease of Army horses and mules in the Philippine Islands during the past thirty years.
2. During the past, treatment of dhobie itch with various fungicidal and bactericidal drugs has been generally unsatisfactory, consequently a number of valuable infected animals have been condemned and destroyed.
3. The general impression that this condition might be due to a trichophyton has not been substantiated since no organisms of this type were found during the microscopic and culture examination of two hundred twenty-one specimens from typical lesions, and cutaneous inoculation of guinea pigs.
4. *Staphylococcus albus* was present in all cultures; *S. aureus* in a smaller proportion; and *S. citreus* in a few.
5. The fact that the condition is most apt to occur in animals living in the open, or stabled in unscreened stalls, particularly near swampy or brush-covered ground, and is most prevalent during the warm rainy season, together with the fact that protection of portions of a horse's skin from insects by covering it with a canvas jacket prevented the development of lesions, while unprotected areas became infected, seems to point to an insect cause.
6. During this investigation it has been shown that severe, long-standing cases of dhobie itch can be cured in a short time without any medication or grooming by the simple procedure of placing the infected animal in an insect-free screened stall at night.

ACKNOWLEDGEMENT

Acknowledgement is made to Majors Leninger and Greenlee, Captains Buffin and Sierveld, and Lieutenant Hill, for their interest and coöperation in furnishing material and their assistance in carrying out this investigation.

NOTE.—After this article was submitted for publication, Captain C. S. Williams, V. C., United States Army, in an article appearing in the Veterinary Bulletin, U. S. Army, 24, No. 1, January, 1930, calls attention to this disease as occurring among Army horses in Hawaii and reports cures by use of the screened-stall method.

ILLUSTRATIONS

[Photographs by the Signal Corps, United States Army.]

PLATE 1

FIG. 1. Type of screened stall used in the study of equine dhobie itch.

2. Horse 24V2 (cases 4 and 9). This was a case of chronic dhobie itch with a history of several recurrences. Photograph taken after screening, in January, 1929. This case recurred late in 1929 and was used as a control in experiment embracing cases 7, 8, and 9.

PLATE 2

FIG. 1. Horse 23V0 (case 7) before being placed in screened stall.

2. Horse 23V0 (case 7) after being placed in screened stall. Note the improvement in this animal.

PLATE 3

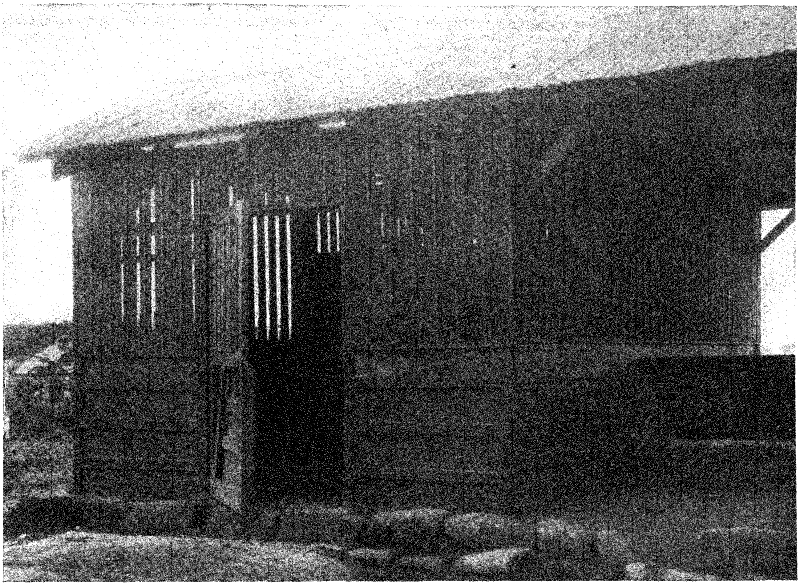
FIG. 1. Horse 01V9 (case 8) before being placed in screened stall.

2. Horse 01V9 (case 8) after being placed in screened stall.

PLATE 4

FIG. 1. Horse 24V2 (case 9) at the beginning of experiment embracing cases 7, 8, and 9.

2. Horse 24V2 (case 9) after experiment during which it was kept in an unscreened stall. Note that the infection became more extensive in this control animal.



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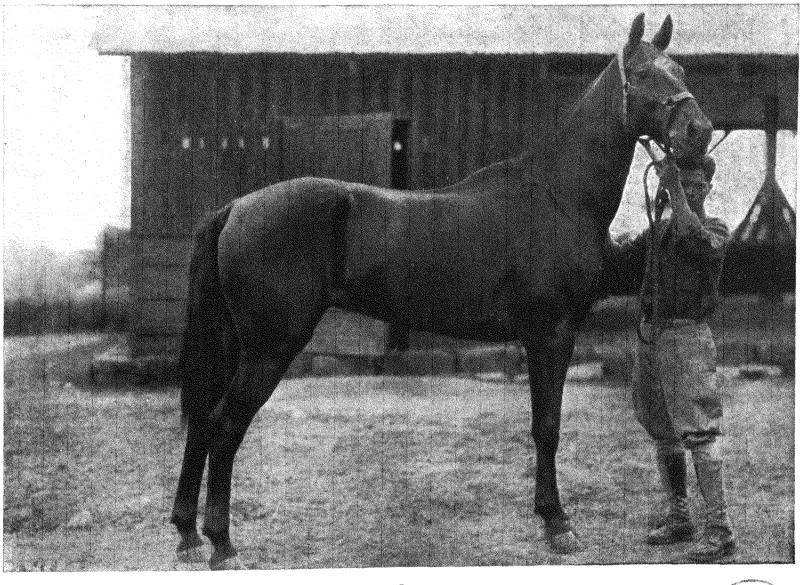

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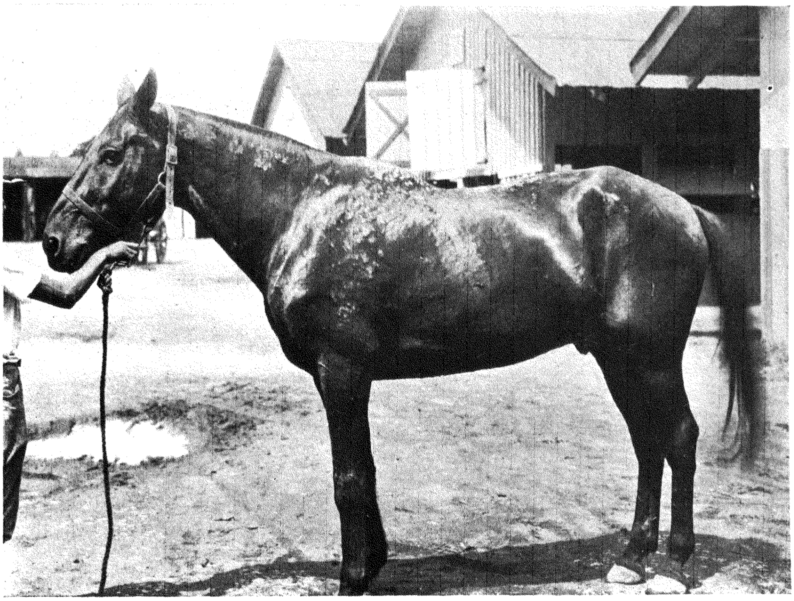

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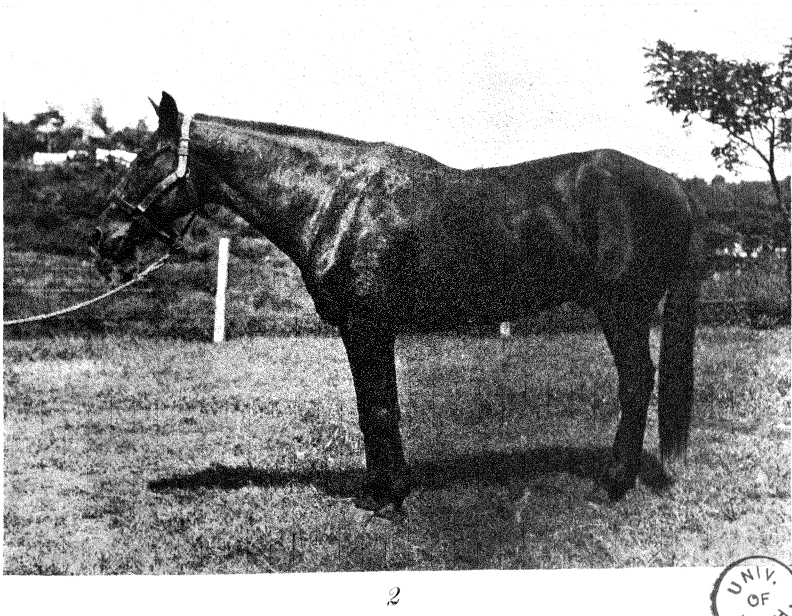

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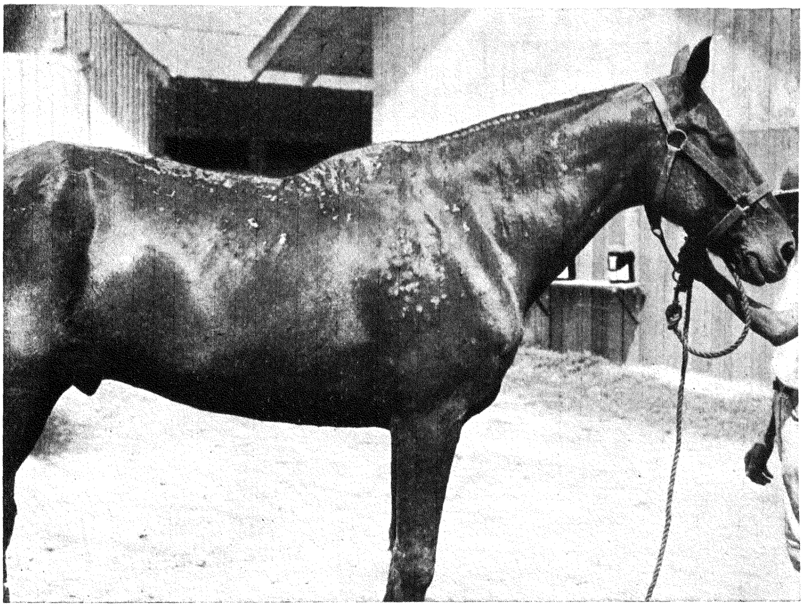

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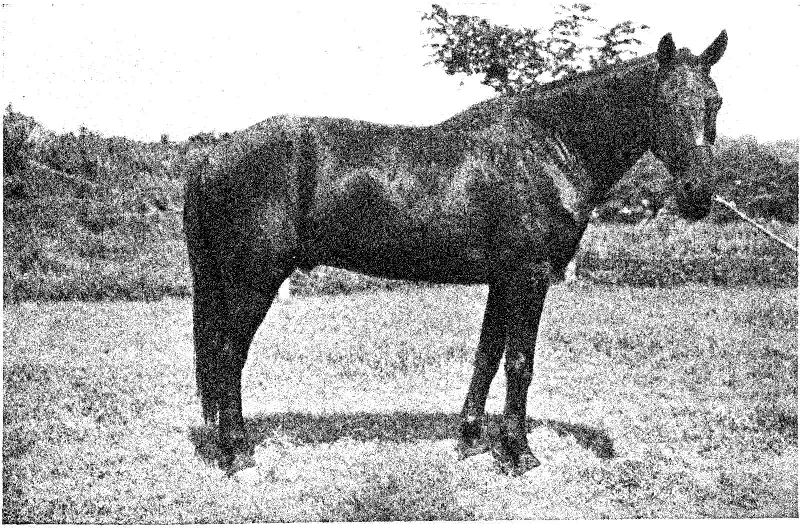

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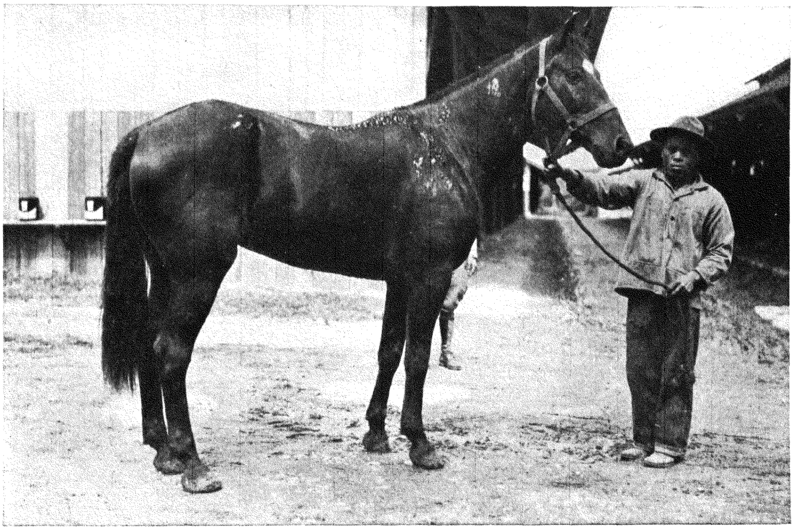

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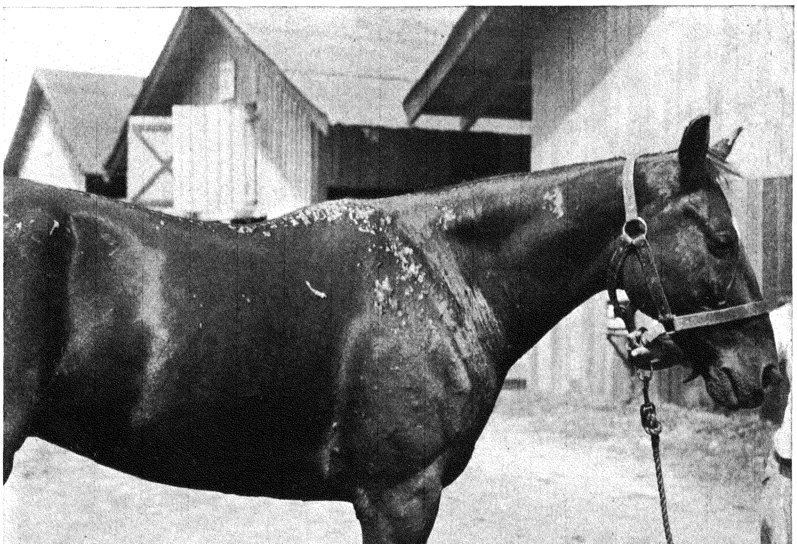

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PLATE 4.

CONTENTS

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THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 42 JULY, 1930 No. 3

CONTRIBUTIONS TO THE CRANIOLOGY OF THE FILIPINOS, II

ON THE CRANIAL DIMENSIONS AND INDICES

By JUAN C. NAÑAGAS

Of the Department of Anatomy
University of the Philippines, Manila

ONE PLATE AND SEVEN TEXT FIGURES

The elucidation of the physical characteristics of the Filipinos and the study of their various relations, direct or remote, to the present or future standing and potentiality of the race can only be adequately approached through direct measurement and close observation on sufficiently ample material from which fair representative data can be derived. Such data are the types of observation to be earnestly sought for as the proper basis for definite information about the race. Even if the sphere of investigation is limited to a few specific parts at a time, the findings derived therefrom will not lack importance and usefulness if the material from which the study is made is fairly comprehensive and adequately representative.

The number of cases represented in this report, although not as numerous as could be desired, is, within a fairly comprehensive extent for the male group, enough to help elucidate certain somatic characteristics of the Filipinos—especially those referring to the cranial portion of the head. It is invariably admitted that in head form, as in various other physical features of the body, the Filipinos have certain outstanding qualities at variance, not only with the rest of the Asiatic races but even with those of other Pacific islanders on the southeast of the great Asiatic continent. It is likewise admitted that even among the dif-

ferent regional constituent groups of the Philippines there are found certain differences that are recognizable even by cursory observation. Into these points and similar related conditions the Department of Anatomy of the University of the Philippines desires to look in the future. It is, of course, obvious that extensive material from all over the Islands is needed satisfactorily to start a study of this nature, which purports to bring out the regional physical differences of the inhabitants of the Philippine Islands, and that some years are needed to gather and assort the statistical data for this type of work.

The literature references at present available on the craniometry of the Filipinos are very limited. The work so far covered on direct measurements of the skull is confined to reports of few cases at a time. The measurements were obtained in most cases from crania sent to European or American museums, collected at random, two to five specimens each, and from different parts of the Islands. Most of the reports emphasize descriptions of the ethnographic features of the crania rather than the accurate presentation of direct dimensional findings. We will refer to some of these works in the part of this paper dealing with the comparative study of the cranial dimensions and indices.

From the craniologic standpoint the series that we are presenting in this paper is by far the largest collection of Filipino skulls yet submitted to craniometric studies; and it is hoped that a preliminary report even on the simple values of means and indices alone of the various cranial measurements, with their frequencies and variabilities, will be of some use.

Most of the few observers have measured the head of Filipinos in living subjects, and the number of cases covered is small. The work of Bean can be considered the most comprehensive so far followed on the cephalometry of Filipinos. His work covers several hundreds of cases, consisting of 377 students from several schools of the City of Manila; 246 adult people of Taytay, of which 183 are males and 63 females; 114 Benguet Igorots from the Mountain Province; and 38 adult men of Cainta. Bean, as well as other workers, dealt mainly with the ethnographic significance of the observation, laying emphasis on certain types of measurements only, rather than on the definite subject matter dealt with in this paper. Nearly 50 per cent of the cases reported by Bean do not include the head dimensions; only the cephalic indices are given. His cases were from a few limited places, and the statistical procedure

followed was not as complete as may be desired for a satisfactory comparison with the statistical data of the present work. Thus, no detailed comparison can be made between past studies and ours on the subject, and only superficial mention can be attempted in the light of past cephalometric work on Filipinos. It is in fact felt that the statistical data here given are better presented anew, or alone under a different point of view, in conformity, we hope, with the present type of biometrical studies followed elsewhere.

MATERIAL AND METHOD

This report is based on the linear measurements of the same series of crania from which the study on the cranial capacity of the Filipino skulls was made in 1927.[1] The method of preparation of the crania and the age and the geographic distribution of this series have been carefully described in the said report. These will be but partially and briefly given in this paper.

In Table 1 is given the age-frequency distribution of this series. The average age of this group is 41 years. From the frequency table it is seen that 30 per cent of the cases are between the ages of 26 and 35 years, and that a little over 53 per cent of them are between the ages of 21 and 40 years. It can be justifiably considered that this series of crania belongs to the adult or mature group of the population.

TABLE 1.—*Age-frequency table of the series.*

Age limits.	Frequency.	Per cent.	Age limits.	Frequency.	Per cent.
Years.			*Years.*		
15–20	21	4.82	66–70	7	1.60
21–25	45	10.32	71–75	6	1.38
26–30	60	13.76	76–80	5	1.15
31–35	70	16.06	81–85	2	0.46
36–40	57	13.07	86–90	2	0.46
41–45	41	9.40	91–95	5	1.15
46–50	43	9.86	96–100	1	0.25
51–55	16	3.67		436	100.00
56–60	27	6.19			
61–65	28	6.42			

From Table 2, on the geographic distribution of the cases, the groups that are most represented in our series are the Eastern Visayan and the Tagalog provinces, comprising more than

[1] Philip. Journ. Sci. 38 (1929) 81–119.

20 per cent of the cases for each group. The next two regions showing a representation of over 10 per cent are the Western Visayan and the Ilocano provinces. This geographic distribution of the series coincides directly with the degree of the actual thickness of population of the different regions of the Philippines, as borne out by the last Philippine census of 1918. We consider this coincidence a happy one, as such direct correlation enhances, in some way, the value of our findings.

TABLE 2.—*Geographic distribution of cases.*

Regions of the Philippines.	Frequency.	Per cent.
City of Manila	29	6.65
Ilocano provinces	53	12.16
Pampanga and Pangasinan provinces	38	8.71
Tagalog provinces	92	21.10
Bicol provinces	27	6.19
Eastern Visayan provinces	102	23.39
Western Visayan provinces	61	14.00
Mindanao and Palawan provinces	21	4.82
Undetermined cases	13	2.98
Total	436	100.00

The method that was followed in taking different dimensions of the crania strictly conforms with the generally accepted method of recording the length, width, breadth, height, circumferences, etc., of the skull through the use of callipers, tapes, goniometer, and craniostat. The last two instruments were constructed locally under definite and accurate specifications as accepted by known foreign scientific centers. They were made under the careful supervision of the well-known mechanical engineer, Mr. Eusebio Morales, then of the Government Ice Plant and of the Cebu Portland Cement Factory, and at present manager of the Binangonan Cement Factory.

Plate 1 represents some of the instruments employed in taking and recording the linear and angular dimensions of the skulls at our disposal. A brief statement of how the various dimensions, considered in this paper, were taken directly from the cranium is as follows:

1. *Maximum length of the cranium, or greatest anteroposterior diameter.*—Measured from the most prominent point of the glabella to the most projecting point of the occiput (opisthocranium) as determined by callipers.

2. *Maximum breadth of the cranium, or greatest transverse diameter.*—This is the greatest horizontal and transverse diameter of the cranium wherever it can be found, excepting on the mastoid processes, as measured by callipers.

3. *Cranial height, or basilobregmatic height.*—Measured from the middle of the anterior edge of the foramen magnum (basion) to the median point of the coronal suture on the top of the skull. This dimension is perpendicular to the Frankfort plane and is measured with callipers while the skull is set up firmly in the craniostat.

4. *Auricular height, or auriculobregmatic height.*—This is measured with the vertical scale and the sliding arms of the goniometer from the superior border of the auditory meatus to a point within the horizontal plane of the bregma.

5. *Minimum breadth of the forehead.*—The shortest horizontal distance from one temporal crest to the other on the frontal bone, as measured by callipers.

6. *Bimastoid diameter.*—Measured between the most prominent external elevation of the two mastoid processes by callipers.

7. *Sagittal arc of the cranium.*—This is measured from the nasion anteriorly, over the surface of the vertex through a sagittal plane, to the middle of the posterior rim of the foramen magnum (opisthion). This is taken with a fine steel tape applied on the surface of the vault.

8. *Transverse arc of the cranium.*—Measured from the upper rim of one auricular passage to that of the other with a tape applied transversely over the vault in such a manner that it will pass over the bregma.

9. *Horizontal circumference of the cranium.*—Measured directly above the superciliary ridges and round the most projecting point of the back of the head with a steel tape. This is supposed to obtain the maximum measurement taken at a horizontal plane with the tape placed at the same level on both sides.

10. *Cephalic index, or length-breadth index.*—Obtained from the percental relation of the length and breadth dimensions of the cranium.

11. *Vertical index, or length-height index of the cranium.*—Derived from the percental relation of the length and height measurements of the cranium.

12. *Breadth-height index of the cranium.*—Derived also from the percental relation of the breadth and height dimensions of the cranium.

In Tables 1 and 2 only the male cases are included as measured by us. The female crania that we have been able to collect are unfortunately very few, consisting of only twenty-three. Because of this limited number, the data and findings obtained from the female group are simply and briefly submitted without discussing to any great extent their relative importance to one another. Similarly, no detailed attempt is made in comparing them with other reported data on craniometry as attempted on the findings and results obtained from the male group of our series.

ANTEROPOSTERIOR DIAMETER, OR LENGTH, OF THE CRANIUM

Male.—The mean anteroposterior diameter of the male crania under study is 175.5 ± 0.69, with a minimum record of 156 millimeters and a maximum of 196 millimeters, thus giving a difference of 40 units. Table 3 and fig. 1, B, show that the frequency distribution of the anteroposterior diameter of the male crania begins to rise rather rapidly at 160 millimeters, from which it continues to ascend very rapidly until it attains the maximum at 172 millimeters. From this point of maximum frequency the descent is symmetrically rapid to 187 millimeters, from which the descent is slower. The great frequency is between the diameters of 165 and 180 millimeters, comprising in all 308 cases, or 70.3 per cent of the total number of male cases studied. The maximum frequency is between 170 and 175 millimeters, covering 120 cases, or 27.4 per cent of the total number. This range of maximum covers a class in which the mean value of the anteroposterior diameter of these crania is found.

The standard deviation for the anteroposterior diameter of this series of crania is 6.4 ± 0.49, and the coefficient of variation is 3.34 ± 0.09.

Female.—The mean anteroposterior diameter of the twenty-three female crania is 167 ± 0.84, with the minimum record of 156 millimeters and a maximum of 183 millimeters, giving a difference of 27 units. A complete list of the distribution of the anteroposterior diameter of the female crania is given in Table 4. The standard deviation found for this diameter in the female is 6.17 ± 0.61, and the coefficient of variation is 3.69.

TABLE 3.—*Frequency distribution of the anteroposterior diameter of the Filipino crania (438 cases).*

Antero-posterior diameter.	Mean average of each group.	Frequency.	Per cent.	Antero-posterior diameter.	Mean average of each group.	Frequency.	Per cent.
mm.	*mm.*			*mm.*	*mm.*		
155–160	158.5	10	2.3	180–185	182.7	66	15.1
160–165	163.7	34	7.7	185–190	187.1	17	3.9
165–170	168.2	93	21.2	190–195	193.3	3	0.7
170–175	173.1	120	27.4			438	100.0
175–180	177.7	95	21.7				

TRANSVERSE DIAMETER, OR BREADTH, OF THE CRANIUM

Male.—The mean transverse diameter, or breadth, of the cranium we found is 146 ± 0.21, with a minimum record of 128

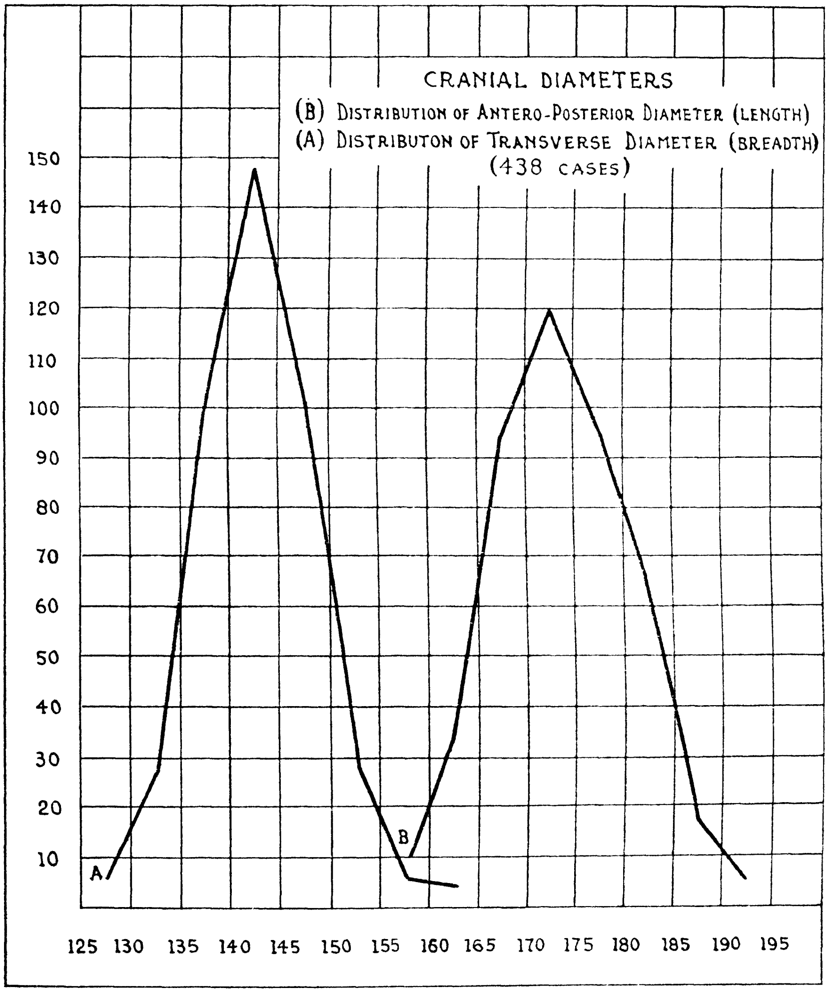

FIG. 1. Distribution of cranial diameters. B, anteroposterior diameter (length): Mean, 175.5 ± 0.69; standard deviation, 6.84 ± 0.49. A, transverse diameter (breadth): Mean, 146 ± 0.21; standard deviation, 6.61 ± 0.15.

millimeters and a maximum of 171 millimeters, giving a difference of 43 units. The table and curve of frequency distribution are shown in Table 5 and fig. 1, A, respectively. The rapid ascent of frequency starts from 135 millimeters, following a steep ascent to the maximum at 148 millimeters, from which it begins to drop, as rapidly as in the ascent, to 155 millimeters. This curve of frequency distribution is quite symmetrical on either side of the maximum point. The range of great frequency is between the diameters 135 and 150 millimeters, comprising in all 350 cases, or 79.9 per cent of the total. The

maximum frequency is between 140 and 145 millimeters, covering 148 cases, or 33.8 per cent. The mean value of the transverse diameter of this series of male crania is just one unit beyond this maximum range of frequency.

The standard deviation given from this diameter is 6.61 ± 0.15, and the coefficient of variation is 3.3 ± 0.05.

Female.—The mean transverse diameter of the female crania in our series is 138 ± 0.78, with a minimum of 127 millimeters and a maximum of 149 millimeters, giving a difference of 22 units. The distribution of the transverse diameter of the twenty-three female crania is given in Table 4. The standard deviation found is 5.62 ± 0.56, and the coefficient of variation is 4.07.

TABLE 4.—*Distribution of anteroposterior and transverse diameters of the female crania (23 cases).*

Antero-posterior diameter.	Number of cases.	Transverse diameter.	Number of cases.
mm.		*mm.*	
156	1	127	1
160	1	128	1
161	1	130	1
162	3	132	1
163	2	133	1
164	1	134	1
165	2	136	2
166	2	138	6
167	1	140	3
168	2	142	2
171	3	143	1
172	1	144	1
173	1	149	2
180	1		23
183	1		
	23		

TABLE 5.—*Frequency distribution of the transverse diameter (breadth) of the cranium in Filipinos (438 male cases).*

Transverse diameter.	Mean average of each group.	Frequency.	Per cent.	Transverse diameter.	Mean average of each group.	Frequency.	Per cent.
mm.	*mm.*			*mm.*	*mm.*		
125–130	129.0	5	1.2	150–155	152.3	37	8.4
130–135	133.4	37	8.4	155–160	157.0	5	1.2
135–140	138.5	100	22.8	160+	167.0	4	0.9
140–145	142.9	148	33.8			438	100.0
145–150	147.2	102	23.3				

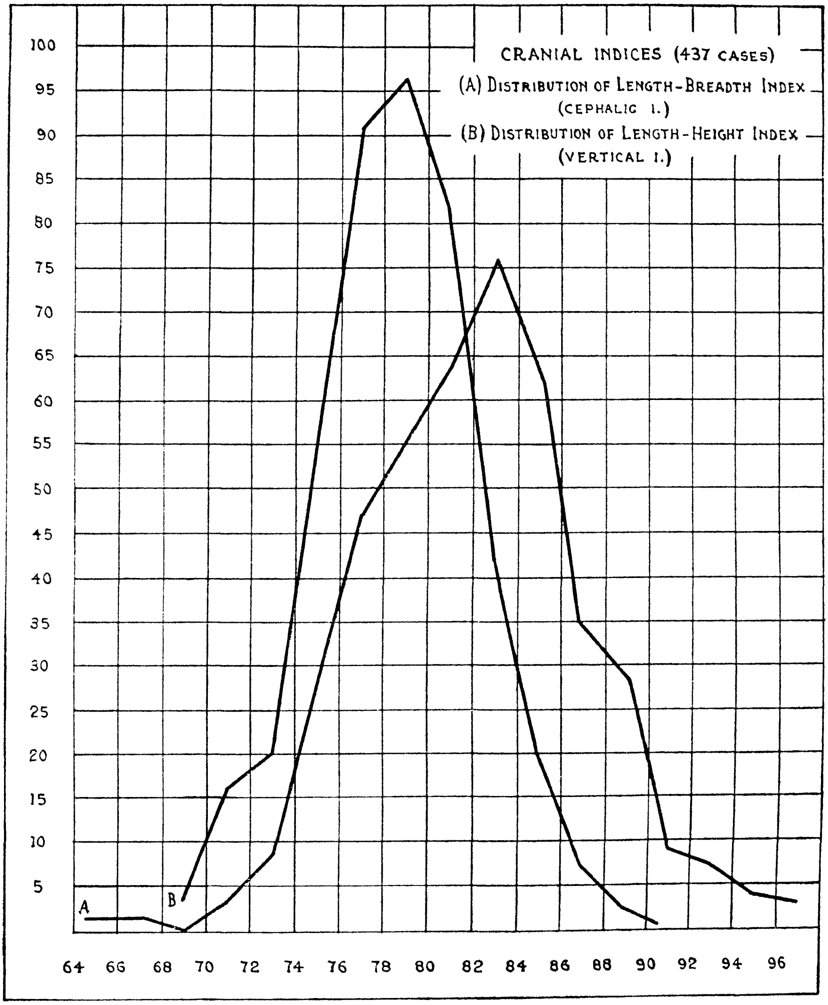

FIG. 2. Distribution of cranial indices. A, length-breadth index (cephalic index): Mean, 81.8 ± 0.16; standard deviation, 4.88 ± 0.11. B, length-height index (vertical index): Mean, 79.9 ± 0.12; standard deviation, 3.86 ± 0.09.

CEPHALIC INDEX, OR LENGTH-BREADTH INDEX OF THE CRANIUM

Male.—The mean cephalic index, or length-breadth index of the cranium, found in our series of skulls is 81.8 ± 0.16, with a minimum of 64.4 and a maximum of 97.6, giving a difference between the two of 33.2 units. The frequency distribution of this cranial index is given in Table 6 and in graphic form in fig. 2, A. The beginning of the rapid rise of frequency distribution is at the index of 74. From here it abruptly rises to the

greatest maximum point at 83 from where the curve of frequency very rapidly descends to 90, from which point few cases are met with as the index goes higher. The highest range of frequency distribution is between the indices of 80 and 86, within which are included 207 cases, or 47.3 per cent of the total male crania.

The standard deviation of the cranial index of this series is 4.88 ± 0.11, and the coefficient of variation is 5.95 ± 0.12.

The distribution of cranial length-breadth index in reference to types is shown in Table 6. The greatest frequency is in the brachycephalic type of cranium, comprising 207 cases, or 47.3 per cent of the total number of cases. The next most frequent is the mesocephalic type, covering 131 cases, or 30 per cent of all cases. The hyperbrachycephalic type (between the indices of 86 and 92) comprises 63 cases, or 14.4 per cent of the total. Of the extreme types 4.6 per cent belong to the ultrabrachycephalic, 2.6 per cent to the dolichocephalic, 0.7 per cent to the extreme brachycephalic, and 0.4 per cent to the hyperdolichocephalic.

TABLE 6.—*Frequency distribution of the cephalic index (length-breadth index) of the Filipino crania (437 cases).*

Cephalic index.	Mean average of each group.	Frequency.	Per cent.	Type.
mm.	*mm.*			
64–66	64.4	1	0.2	Hyperdolichocephalic; 2 cases, or 0.4 per cent.
66–68	67.3	1	0.2	
68–70				
70–72	71.7	3	0.7	Dolichocephalic; 11 cases, or 0.26 per cent.
72–74	73.2	8	1.9	
74–76	75.2	28	6.4	Mesocephalic; 131 cases, or 30 per cent.
76–78	77.1	47	10.8	
78–80	79.0	56	12.8	
80–82	80.9	69	15.6	Brachycephalic; 207 cases, or 47.3 per cent.
82–84	83.0	76	17.4	
84–86	85.1	62	14.3	
86–88	86.8	35	8.0	Hyperbrachycephalic; 63 cases, or 14.4 per cent.
88–90	88.9	28	6.4	
90–92	91.2	9	2.1	
92–94	93.0	7	1.6	Ultrabrachycephalic; 20 cases, or 4.6 per cent.
94–96	95.4	4	0.9	
96–98	97.3	3	0.7	Extreme brachycephalic; 3 cases, or 0.7 per cent.
		437	100.0	

Female.—The mean length-breadth index of the female crania is 82.5 ± 0.61, with a minimum of 70 and a maximum of 90, giving a difference of 20 units between the extremes. The dis-

tribution of the female cases in reference to this cranial index is given in Table 7. The standard deviation of this index in the female is 4.35 ± 0.43, and the coefficient of variation is 5.3 ± 0.20. As in the male group, the greatest frequency is found in the brachycephalic type of cranium, covering more than one-half of all the female cases here reported.

TABLE 7.—*Distribution of length-breadth and length-height indices in Filipino female crania (23 cases).*

Length-breadth index.	Cases.	Length-height index.	Cases.
70	1	72	1
75	1	73	2
78	2	76	1
80	1	78	6
81	4	79	2
83	3	80	3
84	3	81	5
85	2	82	1
86	2	83	1
87	3	85	1
90	1	Total	23
Total	23		

COMPARATIVE STUDY ON THE ANTEROPOSTERIOR AND TRANSVERSE DIAMETERS AND THE LENGTH-BREADTH INDEX OF THE CRANIUM

COMPARATIVE STUDY BETWEEN THE MALE AND FEMALE CRANIAL DIMENSIONS IN FILIPINOS

The anteroposterior and transverse diameters are both relatively longer in the male than in the female Filipino crania. As seen in Table 8, the differences between the two diameters are almost identical in the two, amounting to around 8 millimeters greater for the male crania. The extents of the range of the two diameters are both greater in the male than in the female, reaching about 40 units more in the male for both diameters. The range between the minimum and maximum records of the female cranial diameters is 27 and 22 units in the anteroposterior and transverse diameters, respectively. The minimum diameters (length and breadth) recorded in both sexes are identically the same, 156 millimeters for the anteroposterior and about 127 millimeters for the transverse diameter. The maximum records, however, in the two diameters are both larger in the male crania, the excesses being 13 and 22 millimeters, respectively, for the anteroposterior and transverse diameters.

TABLE 8.—*Comparative table of cranial diameters and indices in male and female Filipinos.*

Sex.	Cases.	Anteroposterior diameter.				Transverse diameter.			
		Mean.	Minimum.	Maximum.	Difference.	Mean.	Minimum.	Maximum.	Difference.
		mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Male	438	175.5±0.69	156	196	40	146±0.21	128	171	43
Female	23	167 ±0.84	156	183	27	138±0.78	127	149	22
Difference	------	8.5	0	13	------	8	1	22	------

Sex.	Cases.	Length-breadth index.			
		Mean.	Minimum.	Maximum.	Difference.
Male	438	81.8±0.16	64.4	97.6	33.2
Female	23	82.5±0.61	70.0	90.0	20.0
Difference	--------	—0.7	—5.6	+7.6	--------

The cephalic, or cranial, index of the female is slightly higher than that of the male; that is, the female cranium in Filipinos is slightly more brachycephalic than that of the male. The mean index for the male is 81.8 and for the female 82.5. As in the minimum and maximum range in the diameters, that of the cranial index is equally wider in extent in the male than in the female. These are, respectively, 33.2 and 20 units for the male and the female. Under this condition the minimum record reached in the cranial index is smaller, and the maximum record larger, in the male than the extremes attained in the female. In other words, the limit of extremes in the cranial index is wider in the male, reaching farther at each end. The great difference in the number of cases in the two groups probably explains this condition in the findings.

The differences between the male and female cranial dimensions mentioned above should be taken only provisionally, until a more complete report on the female cranial measurements in Filipinos, from a more comprehensive group of cases, is obtained. The limited number of cases represented by the female data in this work does not warrant the conclusive acceptance of the facts found here on the comparative study between the male and female cranial dimensions.

The comparative standing of the variability in the cranial diameters of the male and female groups is shown in Table 9. As seen from this comparative table of standard deviation and coefficient of variation, the degree of absolute variability is

slightly greater in the male than in the female group for the anteroposterior diameter. For the transverse diameter it is slightly greater in the female. In the length-breadth index the degree of variability is a trifle more in the male.

TABLE 9.—*Comparative table of variability in the cranial diameters and indices of the male and female Filipinos.*

Sex.	Cases.	Anteroposterior diameter.		Transverse diameter.	
		Standard deviation.	Coefficient of variation.	Standard deviation.	Coefficient of variation.
Male	438	6.84±0.49	3.3 ±0.07	6.61±0.15	3.30±0.05
Female	23	6.17±0.61	3.69±0.13	5.62±0.56	4.07±0.18

Sex.	Cases.	Length-breadth index.	
		Standard deviation.	Coefficient of variation.
Male	438	4.88±0.11	5.95±0.12
Female	23	4.35±0.43	5.30±0.20

COMPARATIVE STUDY ON THE CEPHALIC DIMENSIONS OF THE DIFFERENT TRIBES OF FILIPINOS

Before attempting to compare our results on the cranial dimensions with those of other workers on the same subject, but on the living cases, in Filipinos, it is necessary to reduce our data to comparable units. That is, to calculate the cephalic diameters from the actual cranial diameters here obtained. This should obviously be so, as past observations, on the whole, were made on living persons, quite different from ours that were obtained from stripped crania. The difference of the thickness of the soft tissues of the scalp has, therefore, to be reckoned in making the desired comparison.

From actual measurements made on embalmed cadavers the average thickness of the scalp in Filipinos for the various regions of the head was found to be as follows (Table 10):

TABLE 10.—*Thickness of the scalp in Filipinos as obtained from embalmed cadavers (male, 50 cases; female, 21 cases; by Nañagas).*

Sex.	Forehead.	Right temporal.	Left temporal.	Occipital.	Vertex.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
Male	2.5	4.9	4.6	5.8	3.1
Female	2.5	3.4	3.8	4.2	3.0

From Table 10 we have calculated the most probable cephalic diameters of our group by adding the corresponding thickness of the tissues of the scalp, at the points of measurement, to the cranial dimensions actually obtained. This will give the approximate cephalic diameters (as if obtained directly from the living) for our present series. Apropos of this point, it is necessary to mention that for the more exact calculation of cephalic diameters from cranial diameters, the degree of contraction of the soft tissues of the scalp after death and embalmment and that of the cranium after drying should both be taken into consideration in the process. These two factors we fail to include in our calculation of the cephalic diameters. We are not in possession of sufficient local data on index of relative contractions of either the scalp or the cranium to enable us to add such factors in our calculation. Table 11 gives the calculated anteroposterior and transverse diameters of the head for the present series.

TABLE 11.—*Calculated cephalic diameters in Filipinos from actual cranial diameters as obtained in the present work.*

Sex.	Anteroposterior diameter.			Transverse diameter.		
	Mean.	Minimum.	Maximum.	Mean.	Minimum.	Maximum.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Male	186.4	166.9	206.9	158.0	140.0	183.0
Female	176.3	165.3	192.3	147.7	136.7	158.7

When our calculated cephalic dimensions were compared with those reported by other observers on the cephalometry of Filipinos, it was found that there were only little differences in the results. Table 12 is a comparative summary of all data so far reported on the cephalometry of the Filipinos that are locally available. It is seen that the range of difference between the anteroposterior diameters is within the limits of from 1 to 8 millimeters. The range on the transverse diameters, however, is slightly wider, varying from 8 to 17 millimeters. It is to be noted that the Subanuns of Mindanao show the least head length, while the Bontoc Igorots, the first group reported by Jenks, possess the longest anteroposterior diameter. The latter tribe shows also a greater cephalic breadth, surpassed only by

that of the present group. It becomes obvious from such an observation that the Bontoc Igorots possess a comparatively larger head than do the other Filipino tribes represented in Table 12.

In reference to the comparative standing of the cephalic indices of the various tribes it will be noted that almost all the reported records fall within the two middle types of classifications; namely, the mesocephalic (75–80) and the brachycephalic (80–85). The range of differences in the cephalic indices is between 77.5 and 66.6, with the large majority of the data falling more on the brachycephalic type of head. The mean cephalic index found for the present group of mixed Filipinos is within the brachycephalic type. Of the extremes, that of the Benguet Igorots gives the minimum index, and the Bicols show the highest.

The above findings on the comparative study of the head dimensions among various tribes of the Philippines seem to indicate that there exists only a very narrow range of variation in the size of the head in Filipinos, that in the rather limited variation met with in dimensions it is the transverse diameter that varies more, and that the type of head found is either mesocephalic or brachycephalic with an obvious tendency towards the brachycephalic type for the more-civilized tribes of Filipinos.

TABLE 12.—*Comparative table of cephalic dimensions and indices among several tribes of Filipinos as reported by different observers.*

Filipino groups.	Cases.	Age.	Head length.	Head breadth.	Cephalic index.	Observer.
		Years.	*mm.*	*mm.*		
Luzon:						
Benguet Igorots	104	16	188	146	77.6	Bean.
Do.	10		182	141	77.5	Do.
Bontoc Igorots	32		192	152	79.1	Jenks.
Do.	29		185	147	79.1	Do.
Taytay people	182	15–80	183	149.6	81.8	Bean.
Bicols	10				86.6	Montano.
Mindanao:						
Kulamans	27				78.1	Cole.
Bagobos	33				78.8	Do.
Tagkaolos	27				81.5	Do.
Subanuns	20	24–45	177.5	147.6	82.6	Christie.
Bilaans	38				80.4	Cole.
Mandayas	15				84.6	Do.
Mixed Filipinos	437	15–97	186.4	158.0	81.8	Nañagas.

COMPARATIVE STUDY OF CRANIAL DIMENSIONS AND LENGTH-BREADTH INDEX BETWEEN FILIPINOS AND THOSE OF OTHER ORIENTAL RACES

Table 13 shows the relative standing of the length and breadth of the head and the cephalic indices of some of the island races of the China Sea and the Pacific. It will be observed that the cephalic indices do not show a very wide variation among the different insular races and that all of them are within the limits of the two closely adjoining classifications of mesocephalic and brachycephalic types. The lowest cephalic index in these island groups is 74.7, of the Ami tribe of Formosa, and the highest is 86.5, of the Sudanese race.

In head length the Malang tribe of Borneo has the greatest, 193 millimeters, followed closely by that of the Ami tribe of Formosa. In the latter case it appears quite striking that although possessing the next longest anteroposterior diameter, 191 millimeters, yet they possess the next shortest transverse diameter of the head, this being only 153 millimeters. The same condition is observed on the head dimensions of the Malang tribe of Borneo although it is not so striking as in the Ami tribe.

The serial list of cephalic indices in Table 13 shows that only a few members of the insular tribes are classifiable under the mesocephalic type (74–80) and that a greater portion of them are frankly under the brachycephalic type of head (80–86).

It will be observed also from the same table that the Filipinos, although possessing a medium head length of 186.4 millimeters among the island races listed in the table, have the greatest head breadth, amounting to 158 millimeters. The Filipino record in cephalic index falls in the middle position among these insular races.

Table 14 is a comparative list of head length and breadth and cephalic index of southern Asiatic races, as reported by various observers, together with those of Filipinos as met with in the present work. It will be observed that there exists a lesser degree of variation in the principal dimensions of the head among these southern Asiatic races than is observed among the insular races presented in the previous table. This seems to speak for the logical existence of closer kinship and racial homogeneity among the various tribes of the southern part of the Asiatic continent, certainly more than can be expected among the rather scattered insular races of the China Sea and the Pacific. This point needs further detailed study and elucidation, and it is hoped that this may be looked into more satisfactorily in the future. The maximum and minimum head lengths

TABLE 13.—*Comparative table of head lengths and breadths and cephalic indices of insular races in the China Sea and Pacific Ocean.*

Race.	Cases.	Age.	Head length.	Head breadth.	Cephalic index.	Observer.
		Years.	*mm.*	*mm.*		
Formosa:						
Ami	27	20–40	191	143	74.7	Torii.
Yami	44		178	141.3	79.4	Do.
Puyuma	30	20–40	187	150	80.7	Do.
Paiwan	71		186	151	80.9	Do.
Tsurisen	37	20–40	185	153	83.1	Do.
Borneo:						
Malang	16	22–45	193	148	76.8	McDougall and Hadden.
Barawan	12	22–50	189	146	77.3	Do.
Lerong	10	20–60	187	147	78.5	Do.
Punan	18	17–50	183	149	81.3	Do.
Banjerese	33	21–45	181.2	147.4	81.5	Garrett.
Sumatra: Orang Kubu	20	25–50	186.1	146.6	79.0	Hagen.
Land Dyaks	42	16–55	183	144	78.8	Shelford and Hadden.
Timor Island	30		185.6	146.2	78.8	Ten Kate.
Sumba Island	45		186	147.1	79.1	Do.
Tenggerese	130		186	148	79.7	Kohlbrugge.
Savu Island	13		183.4	146.7	79.9	Ten Kate.
Menangkaban	18	25–40	185.6	148.7	80.1	Hagen.
Kayan	19	21–60	188	151	80.2	McDougall and Hadden.
Battas	40	25–50	186.8	149.8	80.3	Hagen.
Nias Island	1,297		181	146.1	80.7	Kleiweg de Zwaan.
Filipino	438	15–97	186.4	158	81.8	Nañagas.
Menangkaban	568	19–60	179.6	147.6	82.1	Kleiweg de Zwaan.
Malays of Deli	23	25–40	181.7	149.5	82.3	Hagen.
Sea Dyaks (Iban)	55	16–60	180	149	82.9	McDougall and Hadden.
Sibuyan	14	17–70	177	147	83.0	Shelford and Hadden.
Solor Island	21		184.4	153.5	83.3	Ten Kate.
Javanese	56	25–60	179.4	151.5	84.4	Hagen.
Do	17	19–55	177.6	150.8	85.0	Garrett.
Madurese	10	25–60	178	151.3	85.0	Hagen.
Sundanese	37	17–41	176.9	151.2	85.5	Garrett.
Macassar	12		180	155	86.2	Ten Kate.
Sundanese	11	25–40	176.3	152.5	86.5	Hagen.

among the southern Asiatics are 188.7 and 175.1 millimeters, respectively, whereas among the insular races these are, respectively, 193 and 176.3. In head breadth there is hardly any difference, but the maximum and minimum cephalic indices of the southern Asiatic are, respectively, 84.3 and 75.7, whereas those of the insular races are correspondingly 86.5 and 74.7, as given in the two comparative tables.

From the same table (Table 14) it is observed that the head length of the Filipinos stands within the higher value of the anteroposterior dimensions of the southern Asiatic races. In

head breadth also, as is the case with the insular races, that of the Filipinos is the greatest among the southern Asiatic races. These two findings clearly indicate that the Filipinos, as far as they are represented by the series reported in this work, possess comparatively larger head dimensions than the majority of southern Asiatic tribes, and that the type of head possessed by them is decidedly more brachycephalic than in the greater number of southern Asiatics.

TABLE 14.—*Head lengths and breadths and cephalic indices of the southern Asiatic races as reported by various observers compared with those of the Filipinos.*

Race.	Cases.	Age.	Head length.	Head breadth.	Cephalic index.	Observer.
		Years.	*mm.*	*mm.*		
Chinese Shans	100	18–60	185.3	140.4	75.7	Ethnological Survey.
Moi	60				77.4	Harmand.
Kachin	99	18–50	185.4	144.8	78.1	Ethnological Survey.
Man	82		181	141	78.1	Girard.
Khasia	80	19–55	183	144	78.6	Waddell.
Chinese (Sze-chuan)	100		188.7	149.7	79.3	Legendre.
Nurmi	65	25–43	188	149.6	79.5	Risley.
Chinese (south)	108	19–65	180.3	143.9	79.8	Ethnological Survey.
Lepcha	57	25–45	183.5	146.7	79.9	Risley.
Chinese (north)	942	20–66	188.5	151.2	80.2	Koganei.
Miao-tse	48				80.2	Bonifacy.
Tipra	58	25–48	181.4	146.1	80.5	Risley.
Shans	99	17–85	180.4	145.3	80.5	Ethnological Survey.
Palaung	100	20–67	180.1	145	80.5	Do.
Burman (Lower)	100	17–61	181.9	146.5	80.5	Do.
Nong	98		177.4	142.9	80.5	Girard.
Hak-ka (Tonkin)	177				80.5	Vaillant.
Burman (Upper)	138	16–58	180.8	145.9	80.6	Ethnological Survey.
Tibetan (east)	108	25–45	186.9	151.4	81.0	Risley.
Thai	201				81.1	Bonifacy.
Magh	80		182.1	148.5	81.5	Risley.
Hak-ka (Hok-lo)	49	25–45	183.0	149.6	81.8	Hagen.
Filipino	438	15–97	186.4	158	81.8	Nañagas.
Talaing	100	19–65	179.8	147.7	82.1	Ethnological Survey.
Taungthus	100	20–60	179.8	147.7	82.1	Do.
Spaw-Karen	110	17–65	180.7	148.5	82.1	Do.
Pwo-Karen	100	19–65	180.2	148.8	82.5	Do.
Annamese	61				82.5	Bonifacy.
Toukinese	533		180.6	149.1	82.6	Girard.
Siamese	59				82.8	Annandale and Robinson.
Thos	293		175.1	145	82.8	Girard.
Laos	56				83.2	Harmand.
Cambodians	60				83.7	Mondiere.
Limbu	50	25–44	181.4	153.1	84.3	Risley.
Chakma	100	25–45	177-9	150	84.3	Do.

From the serial list of cephalic indices in the same table, it is observed that the greater number of southern Asiatics, a little over 72 per cent, are brachycephalic, and the rest fall under the mesocephalic type.

TABLE 15.—*Head lengths and breadths and cephalic indices of the northern Asiatic races as reported by various observers compared with those of the Filipinos.*

Race.	Cases.	Age.	Head length.	Head breadth.	Cephalic index.	Observer.
		Years.	*mm.*	*mm.*		
Ainu	70	20–80	206.3	158.0	76.5	Sakaki.
Do.	95	20–68	193.7	149.7	77.3	Koganei.
Vagouls	75		192.2	149.9	78.3	Roudenko.
Kamchadales	63		188.0	147.6	78.5	Jochelson-Brodsky.
Kariaks	169		189.3	151.8	80.3	Do.
Yukaghirs	59		191.4	153.3	80.4	Do.
Ostiaks	127		187.3	151.0	80.7	Ruodenko.
Asiatic Eskimo	60		189.8	153.0	80.8	Jochelson-Brodsky.
Filipino	438	15–97	186.4	158.0	81.8	Nañagas.
Chuckchis	148		188.2	153.4	82.0	Jochelson-Brodsky.
Buriats	100	21–63	188.0	154.6	82.4	Porotow.
Yakuts	207		190.9	157.8	82.6	Mainow.
Korean	552	20–40	181.4	150.9	83.2	Kubo.
Do.	113	17–59	177.0	148.0	83.3	Chantre and Bourdaret.
Samoyedes	54		186.5	155.2	83.3	Roudenko.
Soyons	72	18–74	190.0	157.0	83.6	Goroschtschenko.
Targust	73		188.1	159.0	84.6	Iwanowski.
Manchu	61	20–40	180.0	156.2	86.8	Torii.
Buriats	181	20–23	180.8	159.3	88.4	Schendrikowskj.

Table 15 is a comparative table of head dimensions and cephalic index of the northern Asiatic races as reported by observers. Those of the Filipinos as obtained from the present work are inserted. It will be immediately noticed that in both head diameters and cephalic index those of the northern Asiatics are comparatively larger than the records for the southern Asiatics and the insular races. The difference, however, with the latter group is relatively less. The maximum and the minimum head lengths of the northern Asiatics are, respectively, 193.7 and 177 millimeters, and for the head breadth they are correspondingly 159.3 and 149.7 millimeters. These values compared with those of the southern Asiatics and the insular races are evidently higher, as shown in Table 16.

It is worth while to know in this connection the comparative standing of the cephalic dimensions of the Filipinos, as found in this group, and of the modern present-day Japanese as extensively reported by Matsumura. The recent comprehensive

TABLE 16.—*Comparative table of head dimensions and cephalic indices of the northern and southern Asiatics and the insular races.*

Race.	Head length.		Head breadth.		Cephalic index.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
	mm.	*mm.*	*mm.*	*mm.*		
Northern Asiatics	193.7	177.0	159.3	149.7	88.4	76.5
Southern Asiatics	188.7	175.1	153.1	140.4	84.3	75.7
Insular races	193.0	176.3	158.0	141.3	86.5	74.7

studies made and reported by the said author on the cephalic measurements of the Japanese will very fittingly and reliably serve as a base for comparison with those met with in this study for Filipinos. Tables 17 and 18 are summary tables of comparison of the anteroposterior and transverse diameters, and Table 19 of the cephalic indices of the two races. It has been observed that there exist rather limited differences between their cephalic diameters. The differences range from 2 to 3 millimeters between the mean values of their anteroposterior diameters, and from 1 to 6 millimeters between the means of their transverse diameters.

TABLE 17.—*Comparative table of head length in the Japanese and the Filipinos.*

Race.	Sex.	Number.	Head length.			
			Mean.	Minimum.	Maximum.	Difference.
			mm.	*mm.*	*mm.*	*mm.*
Japanese	M	6,000	188.55±0.05	163	213	50
Filipino	M	438	186.40±0.69	166.9	206.9	40
Japanese	F	2,000	179.31±0.09	160	204	44
Filipino	F	23	176.30±0.84	165.3	192.3	27

TABLE 18.—*Comparative table of head breadth in the Japanese and the Filipinos.*

Race.	Sex.	Number.	Head breadth.			
			Mean.	Minimum.	Maximum.	Difference.
			mm.	*mm.*	*mm.*	*mm.*
Japanese	M	6,000	152.18±0.04	134	170	36
Filipino	M	438	158.00±0.21	140	183	43
Japanese	F	2,000	146.73±0.07	134	166	32
Filipino	F	23	147.70±0.78	136.7	158.7	22

Tables 17 and 18 show that the head length of the Japanese is a trifle greater than that of the Filipinos for both the male and female groups. In the male this is around 2 millimeters, and in the female it is 3. The greater range between the maximum and minimum values in the Japanese, for both sexes, is very probably due to the differences in the number of cases comprised in the two studies; ours covers fewer cases.

In both the male and female groups the head breadth of the Filipinos is always greater than that of the Japanese. In the male this difference amounts to 6 millimeters, and in the female it is but 1 millimeter.

TABLE 19.—*Comparative table of cephalic indices in the Japanese and the Filipinos.*

Race.	Sex.	Number.	Cephalic index.			
			Mean.	Minimum.	Maximum.	Difference.
Japanese	M	6,000	80.81 ± 0.03	68.78	95.88	27
Filipino	M	438	81.80 ± 0.16	64.40	97.60	33
Japanese	F	2,000	81.92 ± 0.06	68.14	95.32	27
Filipino	F	23	82.50 ± 0.61	70.00	90.00	20

It can be seen from the two preceding tables that the Japanese have a slightly longer anteroposterior diameter, both in the male and female groups, and that the transverse diameter is considerably greater in the Filipinos, both male and female. In head length the Japanese female exceeds the Filipino female more than the Japanese male exceeds the Filipino male. The difference between the former is 3 millimeters and between the latter 2 millimeters. In the male the Filipino has a much longer head diameter than the Japanese, a difference of 6 millimeters. The females of the two races differ in head breadth by about 1 millimeter.

Table 19 shows the comparative standing of cephalic index in Japanese and Filipinos, the findings in these indices between the two races further prove the preceding described condition. In other words, the Filipinos, regardless of sex, have a more-rounded head than the Japanese, and this difference is greater between the males than between the females of the two races. That the Filipinos have a more-rounded head than the Japanese is shown by the fact that although the Japanese have a longer anteroposterior diameter than the Filipinos, yet they have a

proportionally much less transverse diameter. In the female the difference is less striking; that is, although the female Japanese has a slightly longer head yet the transverse diameter is almost equal to that of the female Filipino.

TABLE 20.—*Anteroposterior and transverse diameters of the cranium in various races.*

ANTEROPOSTERIOR DIAMETER.

Race.	Number.	Sex.	Mean.	Standard deviation.	Coefficient of variation.	Observer.
			mm.			
American white	167	M	181.42	8.191	4.514	Todd.
Do	31	F	173.71	8.559	4.927	Do.
American negro	87	M	186.20	6.515	3.498	Do.
Do	17	F	179.23	4.631	2.583	Do.
German	100	M	180.58	6.088	3.371	Lee and Pearson.
Do	99	F	173.59	6.199	3.571	Do.
Greenland Eskimo	34	M	190.50	4.50	2.36	J. Cameron.
Do	34	F	180.50	4.53	2.50	Do.
Australian aborigines	78	M	183.56	7.42	4.04	A. W. D. Robertson.
Do	22	F	175.59	4.73	2.69	Do.
Filipino	438	M	175.50	6.84	3.34	Nañagas.
Do	23	F	167.0	6.17	3.69	Do.

TRANSVERSE DIAMETER.

Race.	Number.	Sex.	Mean.	Standard deviation.	Coefficient of variation.	Observer.
			mm.			
American white	167	M	144.28	5.675	3.933	Todd.
Do	31	F	139.40	5.355	3.841	Do.
American negro	87	M	139.30	5.660	4.063	Do.
Do	17	F	136.41	4.031	2.955	Do.
German	100	M	150.47	5.849	3.887	Lee and Pearson.
Do	99	F	144.11	4.891	3.394	Do.
Greenland Eskimo	34	M	136.0	4.40	--------	J. Cameron.
Do	34	F	129.5	4.27	--------	Do.
Australian aborigines	78	M	130.60	4.28	3.69	A. W. D. Robertson.
Do	22	F	128.73	3.86	3.00	Do.
Filipino	438	M	146.0	6.61	3.30	Nañagas.
Do	23	F	138.0	5.62	4.06	Do.

Table 20 is presented to show the comparative cranial diameters, together with their standard deviations and coefficients of variation, in some of the races of the world that are not included in the previous tables and which we were able to gather from literature locally available. The data on the Filipinos are included for comparison. No attempt will be made to discuss the existing differences between them; it will only be mentioned in relation to this point that through a cursory review of the

other data on physical measurements, these differences between cranial dimensions seem to be within a certain direct proportion, although in a slightly lesser degree, to the differences in their stature.

The table shows that the existing differences in the proportionate relation between the anteroposterior and transverse diameters are very considerable. The relative difference in the Germans shows the most frank type of brachycephalic cranium. That of the Filipinos falls also under the brachycephalic type of head, although slightly less than the former. That of the American white comes under the mesocephalic form, and that of the American negro is between the dolichocephalic and the mesocephalic type. The Greenland Eskimo and the Australian aborigenes possess elongated heads and thus fall frankly under the dolichocephalic form of cranium.

It is noticeable from the table that the female group of nearly all of the races included possesses a more-rounded head than the corresponding male group, thus sustaining the generally accepted opinion that females are more round headed than males.

TABLE 21.—*Cranial indices of the races listed in Table 20.*

Race.	Cranial index.	
	Males.	Females.
American white	79.5	80.2
American negro	74.8	76.1
German	83.3	83.1
Greenland Eskimo	71.3	71.7
Australian aborigenes	71.1	73.3
Filipino	83.1	82.5

Table 21 gives the cephalic indices of the groups considered in Table 20. It will explain better the points referred to above. The indices given were calculated directly from the means of the two diameters given in Table 20. A slight discrepancy will be noticed in the male cephalic index of the Filipinos as given in this table and that mentioned earlier in this paper. This is due to the fact that the index given elsewhere was obtained from the mean of all the indices derived individually from each cranial measurement, whereas that given in this table for the male Filipinos (as that for the female) is calculated directly from the two cranial diameters given in Table 20. Due to some slight discrepancy in the manipulation of figures the results from the

two methods do not exactly coincide. The male cranial index given previously is the one we consider to be the actual cranial index of the male Filipinos; that is, as represented by the present series of crania under study.

We have prepared some comparative tabulations of the distribution of the length-breadth index of the head and cranium of the various races that we have encountered in our references. Table 22 shows this distribution for some of the Asiatic races together with that of the Filipinos, and Table 23 shows that for some races in other parts of the world. In the table of the Asiatic races it is seen that in the Japanese, as well as in the Filipinos, the greatest incidence is found under the brachycephalic type, with a great tendency towards the mesocephalic form. In the Filipinos the greater incidence is also towards the mesocephalic type although the number of cases falling under the hyperbrachycephalic form is greater than that of the Japanese; that is, there is a greater tendency in the Filipinos to hyperbrachycephaly. In the Koreans there is found a much wider range of distribution of the length-breadth index, extending (with a more uniform and fairly high, even distribution of cases) from the mesocephalic to the hyperbrachycephalic type. The greatest height of frequency, however, is also found in the brachycephalic form. The greatest incidence in the Ainus is in the mesocephalic type with the next most frequent tendency towards the dolichocephalic form.

TABLE 22.—*Comparative table of distribution of length-breadth indices of some of the Asiatic races and of the Filipinos.*

Type.	Japanese.		Ainu.		Koreans.		Filipinos.	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Hyperdolichocephalic	5	0.80					2	0.4
Dolichocephalic	287	4.78	21	22.10	18	3.27	11	2.6
Mesocephalic	2,235	37.25	56	58.95	137	24.82	131	30.0
Brachycephalic	2,750	45.83	18	18.95	203	36.78	207	47.3
Hyperbrachycephalic	658	10.97			138	25.00	63	14.4
Ultrabrachycephalic	60	1.00			49	8.87	20	4.6
Extreme brachycephalic	5	0.80			7	1.27	3	0.7
Total	6,000	100.00	95	100.00	552	100.00	437	100.0

Table 23 shows the comparative standing of the frequency of length-breadth indices of several other races. That of the Filipinos is also included for comparison. The Eskimo and the

Long Barrow skulls both show a distinct group of cephalic-index incidence, quite different from the others. In these two races the greatest frequency is in the dolichocephalic type, with the very obvious tendency of next greater incidence towards the hyperdolichocephalic form. In all the other races included there is a fair similarity in the frequency distribution of the cephalic index.

TABLE 23.—*Frequency distribution of cephalic indices of several other races.*

Type.	Long Barrow skulls (66).	Round Barrow skulls (74).	Parisian skulls (1,000).	Bavarian skulls (1,000).	Eskimo skulls (1,000).	Filipino skulls (437).
Ultradolichocephalic	3.0				4.0	
Hyperdolichocephalic	28.8		0.2		35.0	0.4
Dolichocephalic	62.2	4.0	13.7	0.8	51.0	2.6
Mesocephalic	6.0	31.2	41.2	16.3	10.0	30.0
Brachycephalic		41.9	35.7	52.7		47.3
Hyperdolichocephalic		22.9	9.8	26.9		14.4
Ultrabrachycephalic			1.3	3.1		4.6
Extreme brachycephalic			0.1	0.2		0.7

COMPARATIVE VARIABILITY IN HEAD LENGTH, HEAD BREADTH, AND LENGTH-BREADTH INDEX IN THE TWO SEXES IN FILIPINOS AND IN VARIOUS OTHER RACES

Comparing the variability in head length and head breadth in the two sexes in Filipinos, it was found that there exists a fairly parallel variation in the two cranial dimensions as shown in Table 24. In head length the males are absolutely a little more variable than the females although relatively they are less variable than the latter. A parallel condition is found as regards the head breadth, that the males are absolutely more variable, with a greater degree of variability than the females, although they are less variable relatively than the females.

TABLE 24.—*Variability in head length and head breadth in the two sexes in Filipinos.*

Sex.	Number.	Length.		Breadth.	
		Standard deviation.	Coefficient of variation.	Standard deviation.	Coefficient of variation.
Male	438	6.84 ± 0.49	3.34 ± 0.09	6.61 ± 0.15	3.30 ± 0.05
Female	23	6.17 ± 0.61	3.69 ± 0.16	5.62 ± 0.56	4.07 ± 0.07

TABLE 25.—*Comparison of variability in length and breadth of the head and skull in different races, together with that of the Filipinos as found from the present series.*

Race.	Sex.	Number.	Length. Standard deviation.	Length. Coefficient of variation.	Breadth. Standard deviation.	Breadth. Coefficient of variation.	Observer.
Japanese	M	6,000	6.17±0.04	3.27±0.02	4.98±0.03	3.27±0.02	Matsumura.
Do	F	2,000	5.71±0.06	3.18±0.03	4.86±0.05	3.31±0.04	Do.
Ainu [a]	M	95	5.91±0.29	3.05±0.15	4.24±0.21	2.83±0.14	Koganei.
Do [a]	F	71	5.77±0.33	3.13±0.18	4.83±0.27	3.35±0.19	Do.
Korean	M	552	7.10±0.14	3.91±0.08	5.23±0.11	3.47±0.07	Kubo.
Do	F	120	6.59±0.29	3.75±0.16	5.00±0.22	3.42±0.15	Do.
Filipino [a]	M	438	6.84±0.49	3.34±0.09	6.61±0.15	3.30±0.05	Nañagas.
Do [a]	F	23	6.17±0.61	3.69±0.16	5.62±0.56	4.07±0.07	Do.
Copper Eskimos	M		5.9	3.0	4.1	2.7	Jenness.
Do	F		5.8	3.0	3.0	2.0	Do.
Maltese	M		6.63	3.51	5.8	3.81	Buxton.
Do	F		6.11	3.44	5.41	3.74	Do.
Gozo	M		6.55	3.53	5.91	3.89	Do.
Do	F		6.20	3.5	3.84	2.66	Do.
English (Moorfields)	M		5.58	2.95	5.31	3.71	Macdonell.
Do	F		6.02	3.28	5.28	3.84	Do.
English (Whitechapel)	M		6.27	3.31	5.28	3.75	Do.
Do	F		6.22	3.45	4.77	3.54	Do.
Bavarian	M		6.09	3.37	5.85	3.89	Lee.
Do	F		6.20	3.57	4.89	3.39	Do.
French	M		7.20	3.97	6.07	4.21	Fawcett.
Do	F		6.44	3.65	5.06	3.67	Do.
Naguda [a]	M		5.75	3.17	4.60	3.29	Do.
Do [a]	F		5.57	3.14	4.55	3.45	Do.

[a] Skull.

In Table 25 is shown the comparative variability of the head length and breadth of several of the races that have been referred to in the previous parts of this paper. From the work of Matsumura on the Japanese it was shown that the head length of males is both absolutely and relatively more variable than that of the females, while in the head breadth the males relatively are slightly less variable but absolutely are slightly more variable than the females. The comparative condition of variability, therefore, between the Japanese and Filipinos in the males and females is the same for the head breadth and almost the same for the head length, except for the fact that relatively that of the Filipinos is less variable in the males, quite the opposite to that found in the Japanese for the two sexes, where it is the females that are less variable relatively.

The same condition of variability as found in the Japanese is seen for the Ainu in the two sexes in their cranial dimensions; this condition of parallelism in variability in the two yellow races is interesting, as shown in Table 25.

For the rest of the races listed in Table 25, it can be clearly seen that both absolutely and relatively there exists more variability in men in all the races included than in women and that this variability is similarly conditioned for both the head-length and head-breadth dimensions.

The length-breadth index of the cranium of Filipinos, both absolutely and relatively, is more variable in men than in women. This condition of variability between them is shown in Table 26. It also shows that the male group has a greater degree of relative than of absolute variability.

TABLE 26.—*Variability of length-breadth index of the cranium in Filipinos in the two sexes.*

Sex.	Cases.	Standard deviation.	Coefficient of variation.
Male	438	4.88 ± 0.11	5.95 ± 0.12
Female	23	4.35 ± 0.43	5.30 ± 0.20

Comparing the degree of variation in length-breadth index of the Filipinos with that of some of the Asiatic races, as found in the statistical work of Matsumura on the cephalic measurements, we find that in absolute variation the Filipinos, as represented by the present group, are more variable than almost all of the races listed in Table 27 except the Koreans which show slightly more variability. This finding appears to be important, at least

from the Filipino point of view, as regards the hitherto frequent statement made by different authorities that uncivilized races almost always show low variability of cephalic or cranial length-breadth index.

From Table 27 it will be noticed further that the Japanese, both male and female, are relatively less variable than the Filipinos, just as they are less variable absolutely. Of all the Asiatic races listed in the table the Chinese present the least degree of absolute variability.

TABLE 27.—*Comparative table of standard deviation of the cephalic index of Asiatic races together with that of the Filipinos.*

Race.	Cases.	Male.	Female.
Chinese	20	2.38 ± 0.25	
Pakhpo	25	2.75 ± 0.26	
Ainu	95	2.83 ± 0.14	3.05 ± 0.17
Mastuji	28	3.39 ± 0.31	
Kokyar	37	3.56 ± 0.28	
Kirghis	38	3.59 ± 0.28	
Japanese	6,000	3.67 ± 0.02	3.70 ± 0.04
Karanghutagh	21	3.69 ± 0.38	
Turfan	72	3.92 ± 0.22	
Chitrali	22	4.20 ± 0.43	
Sarikoli	40	4.32 ± 0.33	
Khotan	67	4.38 ± 0.26	
Polu	31	4.43 ± 0.38	
Hami	21	4.51 ± 0.48	
Kariya	21	4.58 ± 0.46	
Filipino	438	4.88 ± 0.11	4.35 ± 0.45
Korean	552	4.97 ± 0.10	4.36 ± 0.19

The greater variation in the Filipinos as compared with many of the other Asiatic races is probably due to the relatively greater admixture of extraneous blood, in the Filipino race of today, from which the present series of crania was derived. It is known that for centuries, even before the Spanish occupation of the Philippine Islands, there had already taken place some admixture of Chinese blood, effected through the trade relations that the southern Chinese had with the primitive Malayan Filipinos since early times. With the advent of the Spanish conquest and during the Spanish régime, a period of three centuries, there took place another blood admixture, this time with the Latin Castilian blood which progressed unabated during the three hundred years of Spanish control in the Archipelago. During this time, also, the frequent invasions made by fleets of Chinese pirate boats in various parts of the Islands have further con-

tributed to the greater heterogeneous mixture of blood and have lead to the generalized distribution of the common triracial intermixtures in the Filipino race of the present time. As mentioned in the beginning paragraphs of this paper, the present series of crania under study came from different parts of the Islands and their geographic frequency distribution is quite in direct proportion to the thickness of population of the important regions of the Philippine Archipelago. It is thus fair to state that the lower degree of variability present in the Chinese and Japanese, as shown in Table 27, is probably due to the much purer state of the original racial stock prevailing in these two races, than that which now exists in the Filipino race.

A comparative view on the interracial variation of other races as regards the length-breadth index of the cranium can be well obtained in Table 28, which was taken from the comprehensive work of Matsumura as quoted by him from K. Pearson. It will be seen from this table that there does not appear any considerable preponderance of variability in either sex as far as the standard deviation of the cranial index is concerned. In twelve cases the variability is greater in the male, and in thirteen cases it is greater in the female.

Comparing the degree of variability of the cranial index of Filipinos with those listed in the table, it is also seen that that of the Filipinos falls in the fourth place from the last, the list being arranged in the rising order of standard deviation; that is, between the deviations 4.68 and 5.51 (respectively, those for the Italians and the Ancient Britons). There is, therefore, a greater extent of variability in Filipinos than in most of the races listed in the table, those races being in a much purer state in reference to their original stock and racially more homogeneous than the present-day Filipinos.

BASILOBREGMATIC DIAMETER, OR HEIGHT, OF THE CRANIUM

Male.—The mean height, or basilobregmatic diameter, of the cranium in the present series of Filipino skull is 140.5 $\pm$ 0.19, with a minimum of 123 millimeters and a maximum of 157 millimeters, giving a unit difference of 34. The frequency distribution of cranial height is shown in Table 29 and graphically in fig. 3, B. The graph shows that from the minimum height of 123 millimeters there is a rapid rise of frequency, only interrupted slightly at the lower part, to 132 where there is a slight diminution although the rise continues to around 137 where the frequency reaches its maximum. From this point the fre-

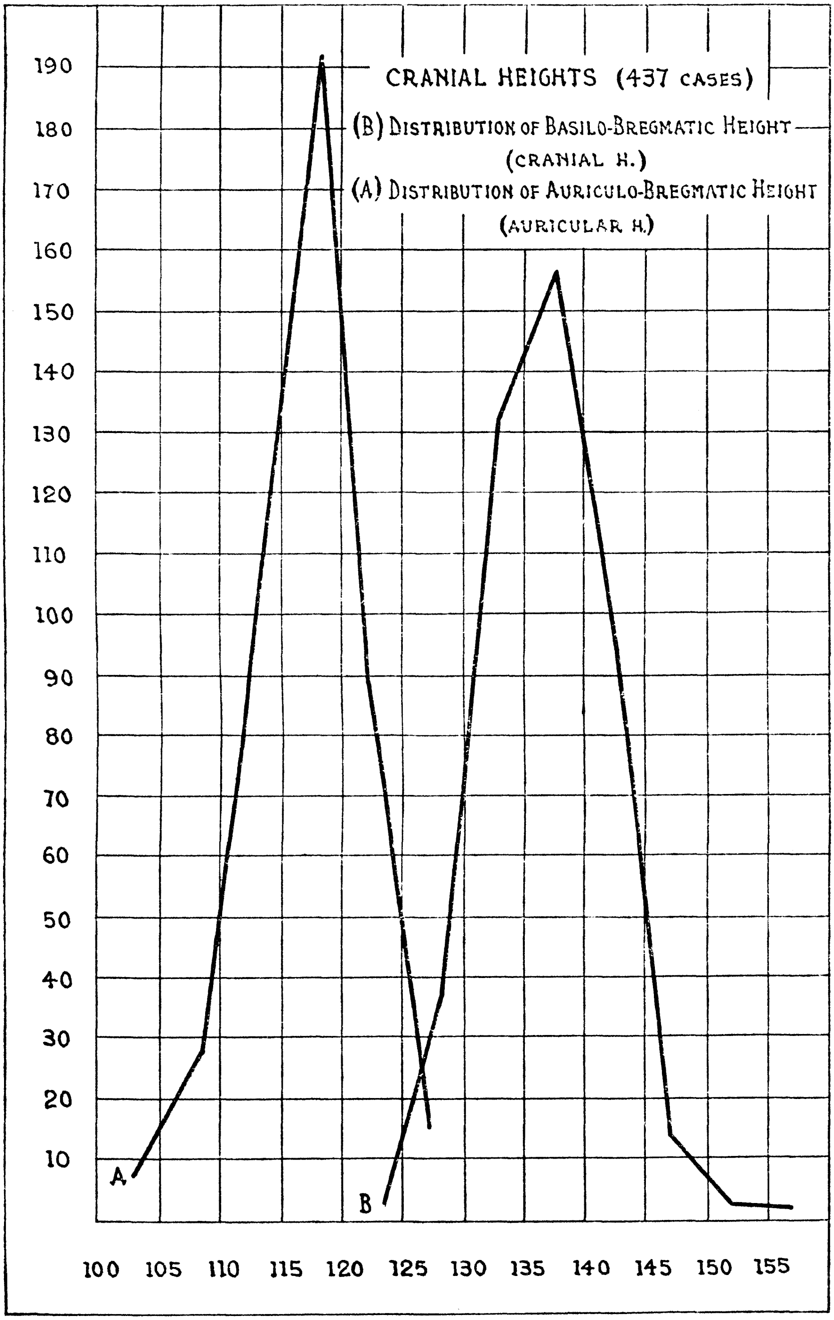

FIG. 3. Distribution of cranial and auricular heights. B, basilobregmatic height (cranial height): Mean, 140.5 ± 0.19; standard deviation, 5.84 ± 013. A, auriculobregmatic height (auricular height): Mean, 115.5 ± 0.15; standard deviation, 4.8 ± 0.11.

TABLE 28.—*Comparative table of standard deviation of length-breadth index of the cranium, male and female, of various races.*

Race.	Male.			Female.		
	Cases.	Mean.	Standard deviation.	Cases.	Mean.	Standard deviation.
Ancient German	24	73.71	2.28	20	74.07	2.35
Andamanese	12	80.57	2.63	12	82.73	2.16
Negro	54	73.28	2.77	23	74.85	3.52
Libyans	89	73.16	2.88	125	74.56	2.88
Australian	29	70.34	2.99	5	72.20	2.02
Punjabi	79	70.66	2.99	17	72.34	3.75
Anglo-Saxon	35	75.00	3.14	21	75.05	2.55
Parisiens de l'Ouest	77	79.53	3.27	41	77.92	4.41
English (Whitechapel)	107	74.73	3.31	102	74.99	3.37
Etruscan	84	78.53	3.31	36	78.21	3.46
Egyptian mummies	336	75.08	3.35	173	76.22	3.36
Romans and R-Britons	36	77.31	3.41	13	76.08	3.45
Friesian	83	77.75	3.57	40	79.03	3.79
German	100	83.41	3.58	100	83.10	2.95
Dutch	25	80.00	3.68	19	79.40	4.91
English	50	77.04	3.80	25	77.31	4.04
Ancient Roman	31	78.09	3.82	12	78.67	3.37
Aborigines, Sweden and Denmark	35	77.86	3.97	13	78.15	4.13
Badensian	67	83.82	4.00	33	83.39	3.38
Polynesian	69	79.29	4.33	57	80.26	4.26
Ancient Gauls	36	78.36	4.44	25	75.40	4.31
Parisiens de la Cite	67	79.25	4.46	42	78.00	2.81
Italian	110	80.79	4.68	30	80.02	3.64
Ancient Briton	114	77.30	5.51	30	76.80	5.42
Swiss	62	78.89	6.36	36	80.51	5.54
Peruvian	47	89.15	8.25	23	91.80	8.47

quency distribution rapidly descends to around 147 from which place only few cases are met with to the maximum height.

The percentage of frequency comprised between the heights of 130 and 140 millimeters is 65.7, or a total of 287 cases. Between the wider range of from 125 to 145 millimeters the percentage of cases included is 95.9, or 419 of the total number of male cases in this series. The standard deviation for the basilobregmatic height is 5.84 ± 0.12, and the coefficient of variation is 4.17 ± 0.09.

Female.—The mean basilobregmatic height met with in the female group is 132 ± 0.72, with the minimum height recorded of 119 millimeters and a maximum of 142 millimeters, showing a unit difference of 23. The standard deviation found in the group is 5.2 ± 0.51, and the coefficient of variation is 3.93, the probable error not determined. The distribution of cranial

height in the twenty-three female cases in our series is shown in Table 31.

TABLE 29.—*Frequency distribution of cranial height, or basilobregmatic height, in Filipinos (437 male cases).*

Cranial height.	Mean average of each group.	Frequency.	Per cent.	Cranial height.	Mean average of each group.	Frequency.	Per cent.
mm.	*mm.*			*mm.*	*mm.*		
120–125	124.0	2	0.5	145–150	147.5	13	3.0
125–130	128.3	37	8.5	150–155	154.0	1	0.3
130–135	133.3	131	30.0	155–160	157.0	1	0.3
135–140	137.8	156	35.7			437	100.0
140–145	142.7	95	21.7				

LENGTH-HEIGHT, OR VERTICAL, INDEX OF THE CRANIUM

Male.—The mean length-height index of the cranium in this series is 79.9 ± 0.12 with the minimum index recorded of 68.4 and the maximum of 90.2, showing a difference of 21.8 units. The standard deviation found for this index is 3.86 ± 0.09, and the coefficient of variation is 4.82.

The frequency distribution of length-height index is shown in Table 30 and in fig. 2, B. From the graph in fig. 2 the curve of frequency shows a steep ascent that is quite uniformly regular, except at the base and near the highest point of the curve. The greatest frequency is at the index of 79 from which point the descent of frequency is very rapid to 84. From this point to the highest index recorded there is a gradual descent where only few cases are encountered.

TABLE 30.—*Frequency distribution of the length-height indices of the cranium and their type classification in Filipinos (437 male cases).*

Vertical index.	Mean average of each group.	Frequency.	Per cent.	Type.
68–70	68.9	3	0.7	Chamæcephalic; 3 cases, or 0.7 per cent.
70–72	71.2	16	3.7	Orthocephalic; 92 cases, or 21.1 per cent.
72–74	73.2	20	4.6	
74–76	75.1	56	12.8	
76–78	77.0	91	20.8	Hypsicephalic; 332 cases, or 76 per cent.
78–80	79.1	97	22.2	
80–82	80.8	82	18.8	
82–84	82.9	42	9.6	
84–86	84.9	20	4.6	
86–88	86.9	7	1.6	Hyperhypsicephalic; 10 cases, or 2.2 per cent.
88–90	89.0	2	0.4	
90–92	90.2	1	0.2	
		437	100.0	

From Table 30 it is seen that the length-height index between 76 and 80 comprises 188 cases, or 43 per cent of the total number of cases, and that between 74 and 82 there are 326 cases, amounting to 74.6 per cent of all the male cases.

The table also shows the number and percentage of distribution of the length-height index in reference to the type classification. Under the classification of low-headed type (chamæcephalic) only 3 cases are included. Under the orthocephalic type there are found 92 cases, or 21.1 per cent of all cases studied. It is under the high-headed type of cranium (hypsicephalic) that the greatest frequency is found in Filipinos as represented by the present series. Under this type there are included 332 cases, amounting to 76 per cent of the total number in the series. This particular finding on the high frequency in the length-height index together with that shown on the length-breadth index frequency, as described in the earlier part of this paper, proves more emphatically once more the commonly admitted consideration that the Malayans are a high-broad-headed race. It should be remembered that in our classification of the length-breadth index there is shown the predominance of the brachycephalic type of cranium, comprising 207 cases, or 47.3 per cent of the total number. In view of these two important findings on the relations of length, breadth, and height of the cranium in Filipinos, it appears that the classification of hypsibrachycephalic type of head for the Filipinos is strongly justified.

Female.—The mean length-height index in the female is 78.9 ± 0.43 with a recorded minimum of 72.1 and a maximum of 85.5, showing a difference of 13 units. The standard deviation is 3.45 ± 0.43, and the coefficient of variation is 5.3 ± 0.20. Tables 7 and 31 show the distribution of vertical index in the twenty-three female cases studied.

TABLE 31.—*Distribution of cranial height and vertical index in the female Filipinos (23 cases).*

Cranial height.		Vertical index.	
mm.			
Below 120	1		
120–125	1		
125–130	5	70–74	3
130–135	11	74–78	3
135–140	3	78–82	14
Over 140	2	82–86	3
Total	23	Total	23

The frequency of type classification of the female crania is quite similar to that of the male group. Of the twenty-three cases, twenty are under the hypsicephalic, or high-headed, type of cranium; the rest, or three, are found under the orthocephalic type. In the type classification of the length-breadth index in the female it has been found also that a great majority are under the brachycephalic type. Considering in this connection the degree of predominance of the length-height index classification, coming almost wholly under the hypsicephalic type, it can be concluded that in the female Filipino crania, as in the male group, the hypsibrachycephalic type of head is the commonest.

BREADTH-HEIGHT INDEX

The other cranial index that is of some use in finding the relative height of the skull, although of less importance than the preceding index, is the breadth-height index.

Male.—The mean breadth-height index of the present group is 94.83 ± 0.15 with a maximum of 112.7 and a minimum of 81.4, showing a unit difference of 31.3. The standard deviation amounts to 4.75, and the coefficient of variation is 1.08. Table 32 gives the frequency distribution of this index for the male group together with the type classification as based on the relation of breadth to height. It will be noted from Table 32 that

TABLE 32.—*Frequency distribution of breadth-height indices of the cranium and their type classification in Filipinos (436 male cases).*

Breadth-height index.	Frequency.	Per cent.	Type distribution.
80–82	1	0.23	Tapinocephalic; 94 cases, or 21.57 per cent.
82–84	3	0.69	
84–86	4	0.92	
86–88	9	2.06	
88–90	39	8.94	
90–92	38	8.72	
92–94	53	12.16	Metriocephalic; 214 cases, or 49.09 per cent.
94–96	80	18.35	
96–98	81	18.58	
98–100	55	12.61	Acrocephalic; 128 cases, or 29.35 per cent.
100–102	35	8.03	
102–104	23	5.27	
104–106	6	1.38	
106–108	7	1.60	
108–110	1	0.23	
110–112	1	0.23	
	436	100.00	

the greatest number of cases is found between 94 and 98, comprising 161 cases, or 36.93 per cent of all the male crania. Between the indices of 92 and 100 there are included 269 cases, amounting to 61.7 per cent of the total number. The curve of distribution of this index is given in fig. 4.

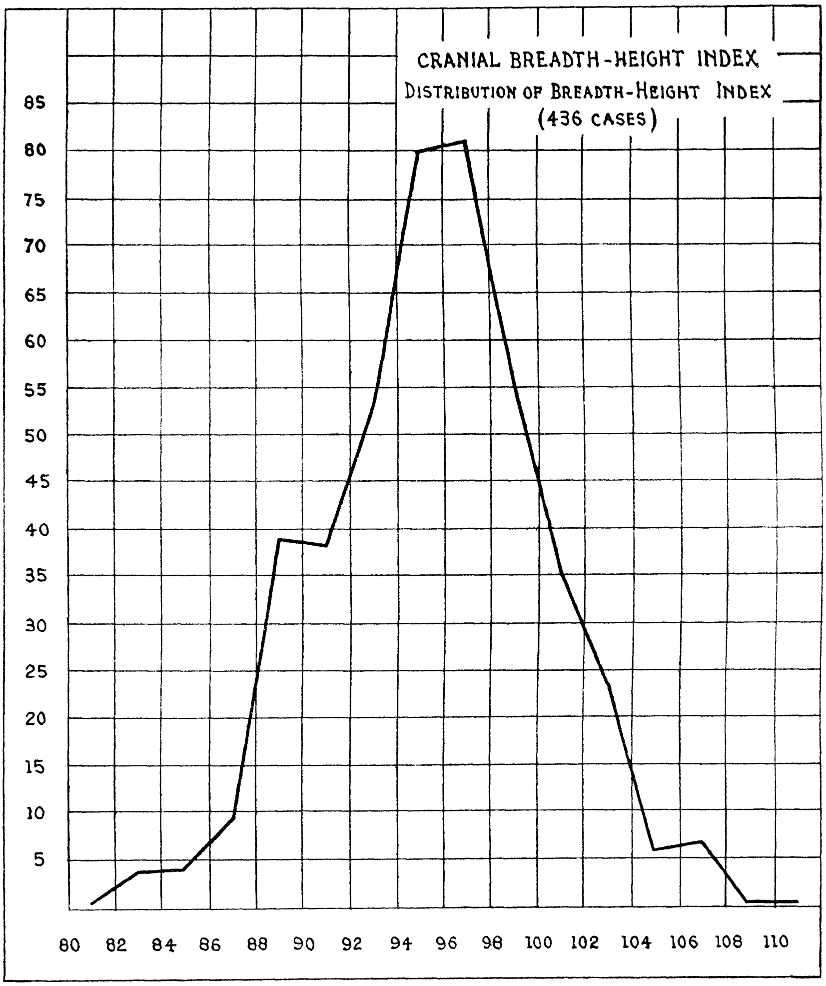

FIG. 4. Distribution of breadth-height index: Mean, 94.8 ± 0.15; standard deviation, 4.75.

Referring to the type classification, as given in Table 32, there are found included under the low flat head, or tapinocephalic type, 94 cases, or 21.56 per cent. Under the metriocephalic type there are 214 cases, or 49.09 per cent; the other 128 crania, or

29.35 per cent, belong to the high-headed, or acrocephalic, type. This finding on the direct relationship between breadth and height dimensions of the cranium quite clearly indicates a close consonance with those findings on type classifications described earlier on the relation of length to breadth and to height. That the greatest number is found under the metriocephalic type with a greater inclination of frequency towards the acrocephalic tends to prove further that the form of head of the Filipinos as a group is really that of the high type.

Female.—The mean breadth-height index in the female group is 95.82 ± 0.52 with a maximum record of 104.9 and a minimum of 85.2, thus showing a difference of 19.7 units. The standard deviation is 3.78, and the coefficient of variation is 3.94. Table 33 shows the complete serial list of the breadth-height index of the 23 female crania in our collection; the cases are also classified into types. The type that covers the greatest number of cases is the metriocephalic, containing 15 of the 23 cases.

TABLE 33.—*List and type classification of breadth-height indices of the female Filipino crania (23 cases).*

Breadth-height index.	Type distribution.
85.2	Tapinocephalic, 2 cases.
91.5	
93.0	Metriocephalic, 15 cases.
93.1	
93.3	
93.8	
93.8	
93.9	
94.3	
94.6	
94.7	
95.0	
96.0	
96.4	
97.4	
97.4	
97.8	
98.1	Acrocephalic, 6 cases.
99.2	
99.3	
100.4	
100.8	
104.9	

COMPARATIVE STUDY OF CRANIAL HEIGHT AND LENGTH-HEIGHT AND BREADTH-HEIGHT INDICES IN THE MALE AND FEMALE AND THEIR VARIABILITY

The mean values of cranial height and length-height index in the Filipino crania are relatively higher in the male than in the female. The height is 140.5 millimeters in the male and 132 millimeters in the female, showing a difference of 8.5 millimeters. In the other cranial diameters already considered the male group invariably shows greater dimensional values. The length-height index is 79.9 in the male and 78.9 in the female. The comparative standing of the breadth-height index in the two sexes is, however, the reverse of that of height and length-height index; that is, it is slightly higher in the female, amounting to 95.8 in the female and 94.8 in the male. This simply signifies, in a rather limited degree, that the cranial vault in the Filipino female is slightly taller in reference to cranial breadth than is the case in the male, in spite of the fact that the latter has a slightly taller head from the standpoint of cranial length as demonstrated by the length-height index. These comparative figures are presented in Table 34, together with the standard deviations and coefficients of variation of these measurements.

TABLE 34.—*Means and variability in cranial height, length-breadth index, and breadth-height index in the male and female of Filipinos.*

Sex.	Cranial height.			Length-height index.			Breadth-height index.		
	Mean.	Standard deviation.	Coefficient of variation.	Mean.	Standard deviation.	Coefficient of variation.	Mean.	Standard deviation.	Coefficient of variation.
	mm.								
Male	140.5	5.84±0.13	4.17	79.9	3.86±0.09	4.82	94.8	4.75	1.08
Female	132.0	5.20±0.51	3.93	78.9	3.09±0.30	3.91	95.8	3.78	3.94

In cranial height as well as in length-height and breadth-height indices the male group shows a greater absolute variation than the female series. However, the degree of this absolute variation in the three items of dimension is very small, amounting to only a fraction of one for each.

Dealing further with variations it is shown in the figures of coefficient of variation in Table 34 that, except for the breadth-

height index, the male group is relatively more variable than the female. In the breadth-height index, on the other hand, the male is relatively less variable than the female.

COMPARATIVE STUDY OF BASILOBREGMATIC DIAMETER AND LENGTH-HEIGHT AND BREADTH-HEIGHT INDICES IN VARIOUS GROUPS OF RACES

The cranial height in Filipinos is found to be comparatively greater than in some of the Pacific races, as demonstrated in the compiled data presented in Table 35. Both the male and female groups of our present series show a cranial height superior to the few races listed in the table. It is also shown that although the females of the Australians and Tasmanians invariably show greater absolute variation than the males, in the Filipinos it is quite the contrary, the male shows the greater absolute variation. In the relative state of variation, as expressed by coefficient of variation, the same parallel condition of variation as in the absolute variation between the two sexes holds true for the races listed in the table.

TABLE 35.—*Cranial height of some Pacific races together with their standard deviation and coefficient of variation.*

Race.	Sex.	Number.	Mean.	Standard deviation.	Coefficient of variation.
			mm.		
Australian	M	78	131.13±0.42	5.54	4.23
Do	F	22	124.50±0.87	6.05	4.86
Tasmanian	M	54	132.11±0.44	4.76	3.60
Do	F	30	126.97±0.66	5.34	4.21
Papuan	M, F	191	131.68±0.26	5.24	3.98
Filipino	M	436	140.5 ±0.19	5.84	4.17
Do	F	23	132.0 ±0.72	5.20	3.93

Comparative tables on cranial height are also included herewith from various races of Asia, Central Europe, and several groups of Eskimos. These are compiled simply for purposes of comparison. Table 36 shows a list of Asiatic races together with the Filipinos, and Table 37 is a list of some central European races together with several Eskimo groups.

TABLE 36.—*Cranial height of some Asiatic races and of the Filipinos.*

Race.	Male.		Female.	
	Number.	Mean.	Number.	Mean.
		mm.		*mm.*
Mongol (Urga)	----------	131.0	----------	----------
Tibetan A	17	131.2	----------	----------
Hindu	10	131.5	14	126.3
Tibetan B	15	134.1	----------	----------
Burmese B	8	134.7	17	131.5
Hylam	39	135.9	----------	----------
Moriori	34	135.9	----------	----------
Burmese A	43	136.0	39	131.4
Tamil	35	136.3	----------	----------
Chinese	69	136.9	4	130.2
Malayan	76	137.4	6	129.0
Hokien	36	137.8	----------	----------
Ainu	88	139.5	----------	----------
Burmese C	7	140.1	18	129.9
Filipino	437	140.5	23	132.0

TABLE 37.—*Length-height index of some European races and Eskimo groups.*

Race.	Male.	Female.
Central Europe:		
Greifenberg	128.7	122.7
Old Bavarian	133.7	128.0
Bavarian Fthls	133.4	128.6
Wurtenberg	130.9	126.2
Laas	128.0	127.0
Walser	131.0	127.0
Wallis	133.0	128.0
Eskimos:		
Greenland	139.5	131.5
Canadian	137.0	----------
Alaskan	137.6	131.9
Asiatic	133.6	132.0

In the preceding tables it is shown that the cranial height of the Filipinos is considerably above that of any Asiatic race included in the list. It is closely approached only by that of the Ainus of Japan. Compared at random with other races (as our literature locally available is not as comprehensive as we desire to have it for more extensive reference) it is also found that the cranial height of the Filipino is likewise superior

to that of any of the races of Central Europe or of any of the Eskimo groups given in Table 37. This condition seems to point rather emphatically to the truthfulness of the common assertion that the most prominent craniologic characteristic of the Malays is the high type of head they possess.

The comparative standing of the length-height index of our series with that of various Asiatic races is presented in Table 38. It is here seen that the length-height index of the Filipino is comparatively higher than that of any of the other races in the list, and is surpassed only by that of the Hylam Chinese.

TABLE 38.—*Length-height index of some Asiatic races together with that of the Filipino (males).*

Race.	Number.	Length-height index.
Tibetan B	14	72.10
Moriori	34	72.80
Tibetan A	14	75.10
Maravar	21	75.20
Ainu	88	75.60
Tamil	35	76.21
Hokien	36	77.02
Chinese	21	77.40
Burmese A	43	78.40
Malayan	76	78.40
Filipino	437	79.90
Hylam	39	80.84

Table 39 presents another list of reported cranial length-height indices of some of the central European races. The length-height index of the Filipinos from our series is likewise higher than any included in the list.

TABLE 39.—*Length-height index of some European races.*

Race.	Male.	Female.
Alamannen	71.50	71.90
Greifenberg	72.40	72.85
Laas	72.50	74.30
Wurtenberg	73.02	73.17
Old Bavarian	74.20	73.90
Wallis	74.59	74.37
Walser	74.73	74.89
Bavarian Foothills	75.30	76.10
Magyar	75.30	73.30
Danis	75.50	76.10
Walach	76.80	75.80

A comparative list of the type distribution of the length-height index of some Asiatic races is presented in Table 40 together with the type classification of this index in the Filipino. The Hylam Chinese shows the greatest frequency in the hypsicephalic type, 97.4 per cent, followed by the Burmese with the frequency of 79 per cent, and then by the Filipino with 76 per cent frequency. The Hylam also shows the least frequency under the orthocephalic type, only 2.5 per cent. The Tibetan B has the least frequency under the hypsicephalic group, only 21.4 per cent, although this race shows the maximum frequency under the orthocephalic type, with a rate of 64.2 per cent.

TABLE 40.—*Type classification of length-height index of some Asiatic races together with that of the Filipino (males).*

Race.	Chamæcephalic (70 or under).		Orthocephalic (70.1 to 75).		Hypsicephalic (75.1 or over).	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Hylam			1	2.56	38	97.44
Burmese			9	20.93	34	79.07
Hakien			10	27.78	26	72.22
Tamil			14	40.00	21	60.00
Tibetan A	1	5.88	6	35.29	10	58.82
Tibetan B	2	14.29	9	64.28	3	21.42
Filipino	3	0.7	92	21.76	332	76.00

SAGITTAL ARC OF THE CRANIUM

Male.—The mean sagittal arc of the present series of crania in the male is 370.2 ± 0.65. The minimum measurement recorded is 325 millimeters and the maximum is 415 millimeters, showing a difference of 90 units. Table 41 shows the frequency distribution of the sagittal arc. The degree of frequency between 350 and 380 millimeters reaches a total of 312 cases, or 72.3 per cent of the entire male series. The highest frequency found inclosed within the shortest series interval is that between 360 and 370 millimeters, which covers 30.4 per cent of all cases. The curve of frequency distribution of sagittal arc is shown in fig. 5, B.

In the assortment of individual data on the measurement of this arc there was met an extraordinary case showing a sagittal arc of 540 millimeters, a record way beyond the ordinary range of this dimension. This special case was separated from the

whole series, to be dealt with later in a special report treating only of extraordinary sets of skulls found in our collection.

The standard deviation found for this arc is 13.5 ± 0.46, and the coefficient of variation is 3.64 ± 0.08.

TABLE 41.—*Frequency distribution of the sagittal arc of the cranium in Filipinos (430 males).*

Sagittal arc.	Mean average of each group.	Frequency.	Per cent.	Sagittal arc.	Mean average of each group.	Frequency.	Per cent.
mm.	*mm.*			*mm.*	*mm.*		
320–330	325	1	0.2	380–390	385	44	10.1
330–340	337	10	2.3	390–400	393	11	2.5
340–350	347	51	11.8	400–410	403	3	0.6
350–360	356	94	21.8	410–420	415	1	0.2
360–370	366	131	30.4			430	100.0
370–380	375	87	20.1				

Female.—The mean sagittal arc in the female is 350.8 ± 0.72 millimeters. The recorded maximum is 369 millimeters and the minimum is 327 millimeters, showing a difference of 42 units. The standard deviation is 12.3 ± 1.22, and the coefficient of variation is 3.5. Table 42 gives the distribution of the sagittal arcs of the twenty-three female crania in the series.

TABLE 42.—*Distribution of sagittal and transverse arcs and horizontal circumference of the cranium in Filipinos (23 females).*

Sagittal arc.		Transverse arc.		Horizontal circumference.	
Interval.	Frequency.	Interval.	Frequency.	Interval.	Frequency.
mm.		*mm.*		*mm.*	
--------	--------	280–285	1	455–460	1
--------	--------	285–290	--------	460–465	1
--------	--------	290–295	4	465–470	1
325–330	1	295–300	2	470–475	2
330–335	2	300–305	1	475–480	2
335–340	3	305–310	2	480–485	4
340–345	1	310–315	5	485–490	3
345–350	3	315–320	4	490–495	2
350–355	2	320–325	3	495–500	4
355–360	6	325–330	--------	500–505	1
360–365	1	330–335	--------	505–510	1
365–370	4	335–340	1	510–515	1
	23		23		23

TRANSVERSE ARC

Male.—The mean transverse arc of the cranium in the male is 320.5 ± 0.51; the maximum arc recorded is 348 millimeters, and the minimum is 293 millimeters. The difference between the two is 55 units.

Table 43 presents the frequency distribution of the transverse arc. The maximum frequency is between 320 and 330, comprising 145 cases, or 33.4 per cent of the total male crania. Between the arcs 310 and 330 there are included 266 cases, amounting to 61.2 per cent of the entire male series. The curve of distribution of the transverse arc is shown in fig. 5, A.

The standard deviation and coefficient of variation of this arc in the male are 10.65 ± 0.24 and 3.32 ± 0.02, respectively.

TABLE 43.—*Frequency distribution of the transverse arc of the cranium in Filipinos (435 males).*

Transverse arc.	Mean average of each group.	Frequency.	Per cent.
mm.	*mm.*		
290–300	296.8	21	4.8
300–310	306.7	84	19.3
310–320	315.9	121	27.8
320–330	325.5	145	33.4
330–340	334.9	50	11.5
340–350	343.2	14	3.2
		435	100.0

Female.—The mean transverse arc of the cranium in the female is 308.6 ± 1.78. The maximum measurement found for this arc is 336 millimeters and the minimum is 282 millimeters, showing a difference of 54 units. The standard deviation of this arc in the female is 12.45 ± 1.26, and the coefficient of variation is 4.04. The distribution of this arc in the twenty-three female crania of our series is given in Table 42.

HORIZONTAL CIRCUMFERENCE

Male.—The horizontal circumference of the cranium in the male Filipinos is 504 ± 0.43. The maximum circumference recorded is 544 millimeters, and the minimum is 460 millimeters, giving a unit difference of 84 millimeters.

Table 44 gives the frequency distribution of this circumference for the male. The highest frequency in any single interval given in the table is found between 500 and 510 millimeters. Between the cranial circumferences of 490 and 520 millimeters there are comprised 311 cases, or 71.6 per cent of the total male crania. The curve of distribution of this circumference is shown

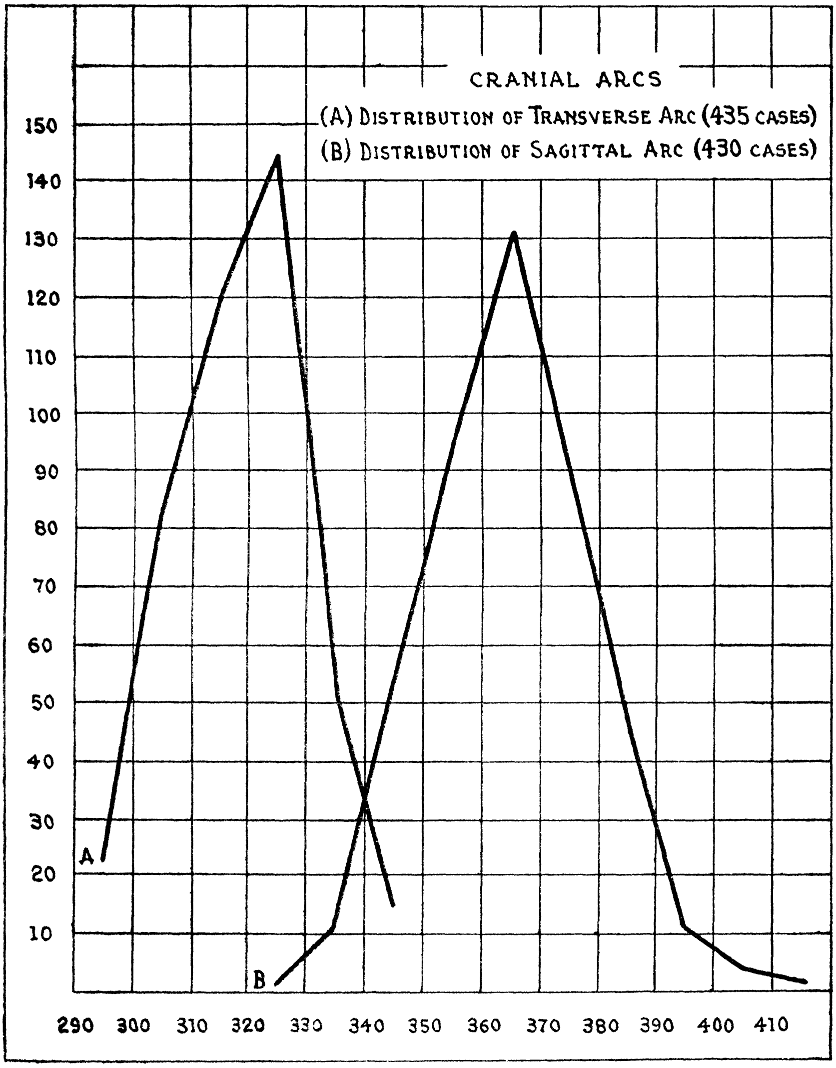

FIG. 5. Distribution of cranial arcs. A, transverse arc: Mean, 320.5 ± 0.51; standard deviation, 10.6 ± 0.24. B, sagittal arc: Mean, 370.2 ± 0.65; standard deviation, 13.5 ± 0.46.

in fig. 6. It will be seen from this curve that the ascent and the descent of frequency are quite uniform and symmetrical in position from the highest point of frequency.

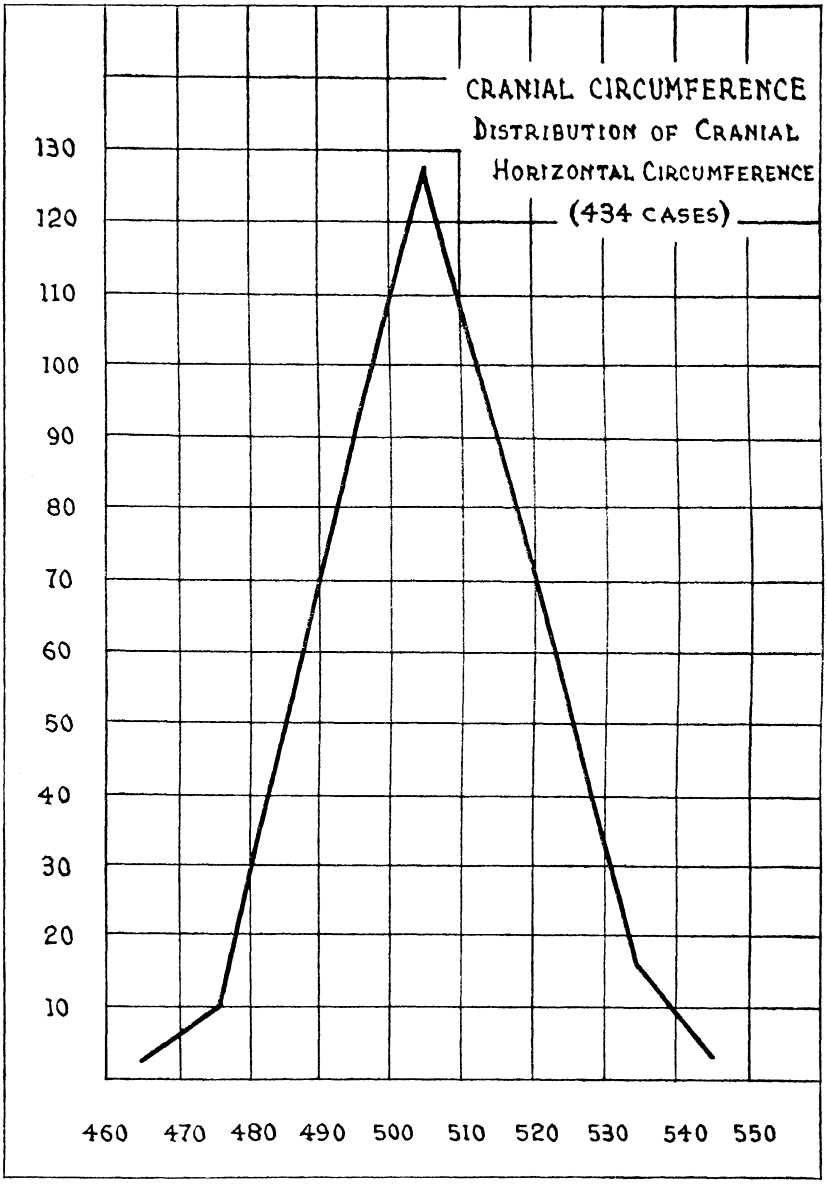

FIG. 6. Distribution of horizontal circumference of the cranium: Mean, 505.8 ± 0.43; standard deviation, 13.5 ± 0.67.

The standard deviation of this arc in the male is 13.5 ± 0.67 millimeters, and the coefficient of variation is 2.67 ± 0.08 millimeters.

TABLE 44.—*Frequency distribution of the horizontal circumference of the cranium in Filipinos (434 males).*

Horizontal circumference.	Mean average of each group.	Frequency.	Per cent.
mm.	*mm.*		
460–470	464.5	2	0.5
470–480	477.7	10	2.3
480–490	486.4	43	9.9
490–500	496.1	96	22.1
500–510	505.2	127	29.2
510–520	515.3	88	20.3
520–530	525.2	50	11.5
530–540	534.1	16	3.7
540–550	543.0	2	0.5
		434	100.0

Female.—The mean horizontal circumference of the female crania is 496.1 ± 1.92; the maximum is 511 millimeters and the minimum is 458 millimeters, giving a unit difference of 53 millimeters. The standard deviation of this circumference is 13.72 ± 1.36; the coefficient of variation is 2.82. The distribution of this circumference for the female is given in Table 42.

COMPARATIVE STUDY OF CRANIAL ARCS AND CIRCUMFERENCE BETWEEN THE MALE AND FEMALE AND THEIR VARIABILITY

The means of sagittal and transverse arcs and horizontal circumference of the cranium between the male and female groups of our series invariably show greater values of circumferential dimensions in the male. The superiority of the male for the sagittal arc is 19.4 millimeters, for the transverse 11.9 millimeters, and for the horizontal circumference 19.2 millimeters.

TABLE 45.—*Variability of the sagittal and transverse arcs and horizontal circumference in the male and female Filipinos.*

Sex.	Sagittal arc.			Transverse arc.			Horizontal circumference.		
	Mean.	Standard deviation.	Coefficient of variation.	Mean.	Standard deviation.	Coefficient of variation.	Mean.	Standard deviation.	Coefficient of variation.
	mm.			*mm.*			*mm.*		
Male	370.2	13.5	3.64	320.5	10.65	3.32	505.3	13.5	2.67
Female	350.8	12.3	3.50	308.6	12.45	4.04	486.1	13.7	2.82

As shown in Table 45 the male group, both absolutely and relatively, has a slightly greater variability in sagittal arc than the female. In the transverse arc, however, the female is more variable, both absolutely and relatively, as shown by the values for the standard deviation and the coefficient of variation of this arc. In the horizontal circumference the same condition of variation exists only to a slight extent; that is, absolutely and relatively, the cranial circumference is very slightly more variable in the female.

COMPARATIVE STUDY OF THE CRANIAL ARCS AND CIRCUMFERENCE IN VARIOUS RACES

The comparative standing of the two arcs and horizontal circumference of the cranium for some of the Asiatic races is shown in Table 46. Those of the Filipinos are included for comparison. It will be observed that the sagittal arc of the Filipinos is one of the three largest among the races listed. In transverse arc the Filipinos are only in the middle row. The horizontal circumference of the present series is smaller than that of a great majority in the list.

TABLE 46.—*Sagittal and transverse arcs and horizontal circumference of the cranium in some Asiatic races (males).*

Race.	Sagittal arc.	Transverse arc.	Horizontal circumference.
	mm.	*mm.*	*mm.*
Hylam	358.9	329.0	500.1
Tibetan A	360.9	310.9	503.6
Tibetan B	361.2	312.9	525.6
Hindu	363.5	302.9	----------
Burmese A	363.7	325.8	505.7
Burmese B	367.0	----------	----------
Tamil	367.6	313.2	498.0
Moriori	368.8	316.1	522.8
Filipino	370.2	320.5	505.3
Ainu	372.8	328.5	522.5
Hokien	377.0	322.0	510.5

Table 47 presents a list of the sagittal and transverse arcs and horizontal circumference of the cranium of some European and African races. This is here given simply to obtain, in a cursory way, an idea of the relative standing of the circumferential dimensions being dealt with here in Filipinos with those of other races similarly studied.

TABLE 47.—*Sagittal and transverse arcs and horizontal circumference of the cranium in some European and African races.*

Race.	Sagittal arc.		Transverse arc.		Horizontal circumference.	
	Male.	Female.	Male.	Female.	Male.	Female.
Europe:	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Wurtenberg (Germany)	367.2	358.1	323.9	314.9	514.1	500.5
Bavarian Foothills	365.8	350.8	327.9	314.5	511.0	495.0
Old Bavarian	365.1	353.4	329.7	318.7	513.0	501.4
Greifenberg (Austria)	364.0	348.9	315.5	302.9	509.8	493.2
Walser (Austria)	365.0	351.0	332.0	323.0		504.0
Danis (Switzerland)	361.0	350.0	328.0	319.0	510.0	495.0
Laas (Northern Italy)	357.0	353.0	314.0	314.0	509.0	504.0
French (soldiers)	365.9		312.2		518.2	
English (Whitechapel)	377.1	362.7	307.9	293.9	524.2	503.8
Africa:						
Modern Egyptian (Cairo)	365.9	352.0	311.8	295.6	501.7	485.1
Modern Negro (North Africa)	367.7		306.8		508.4	
Filipino	370.2	350.8	320.5	308.6	505.3	486.1

AURICULOBREGMATIC HEIGHT OF THE CRANIUM

Male.—The mean auriculobregmatic height of the male crania is 115.5 ± 0.15. The maximum height encountered is 130 millimeters and the minimum is 103 millimeters, giving a unit difference of 27 millimeters between the two extremes.

The frequency distribution of this dimension is shown in Table 48 and in graphic form in fig. 3, A. The maximum degree of frequency is met with in the serial interval of 115 to 120 millimeters, where it reaches 191 cases, making 43.8 per cent of all the male group. Between the auricular heights of 110 and 120 millimeters there are included 301 cases, or a total of 68 per cent of the group.

TABLE 48.—*Frequency distribution of the auriculobregmatic height of the cranium in Filipinos (436 males).*

Auricular height.	Mean average of each group.	Frequency.	Per cent.
mm.	*mm.*		
100–105	103.8	7	1.6
105–110	109.0	27	6.2
110–115	113.5	110	25.2
115–120	118.0	191	43.8
120–125	122.2	88	20.2
125–130	126.9	13	3.0
		436	100.0

The standard deviation and the coefficient of variation of this height are 4.8 ± 0.11 and 3.09 ± 0.07, respectively.

Female.—The mean auriculobregmatic height in the female is 113.1 ± 0.6. The maximum recorded is 122 millimeters and the minimum is 103 millimeters, giving a difference of 19 units. Table 49 gives the complete list of auriculobregmatic height in all the female cases in our series. The standard deviation found is 4.29 ± 0.42, and the coefficient of variation is 3.79.

TABLE 49.—*Distribution of auriculobregmatic height, minimum frontal diameter, and bimastoid diameter in the female Filipinos (23 cases).*

Auriculobregmatic height.		Minimum frontal diameter.		Bimastoid diameter.	
Interval.	Frequency.	Interval.	Frequency.	Interval.	Frequency.
mm.		*mm.*		*mm.*	
----------	--------	84-86	4	104-108	2
100-104	1	86-88	2	108-112	--------
104-108	3	88-90	4	112-116	2
108-112	4	90-92	4	116-120	10
112-116	10	92-94	5	120-124	5
116-120	4	94-96	3	124-128	1
120-124	1	96-98	1	128-132	3
	23		23		23

MINIMUM FRONTAL DIAMETER

Male.—The mean minimum frontal diameter in the male is 95.4 ± 0.14. The greatest diameter met with in the group is 112 millimeters and the least is 78 millimeters, giving a unit difference of 34 millimeters.

Table 50 shows the frequency distribution of the minimum breadth of the forehead, and fig. 7, A, that of the frequency curve. The highest frequency found is between 90 and 95 millimeters, covering 194 cases, making 44.4 per cent of the entire male group. Between the diameters 90 and 100 millimeters there are comprised 309 cases, amounting to 70.7 per cent of the total male cases.

The standard deviation and the coefficient of variation of this diameter in the male are 4.55 ± 0.10 and 4.7 ± 0.06, respectively.

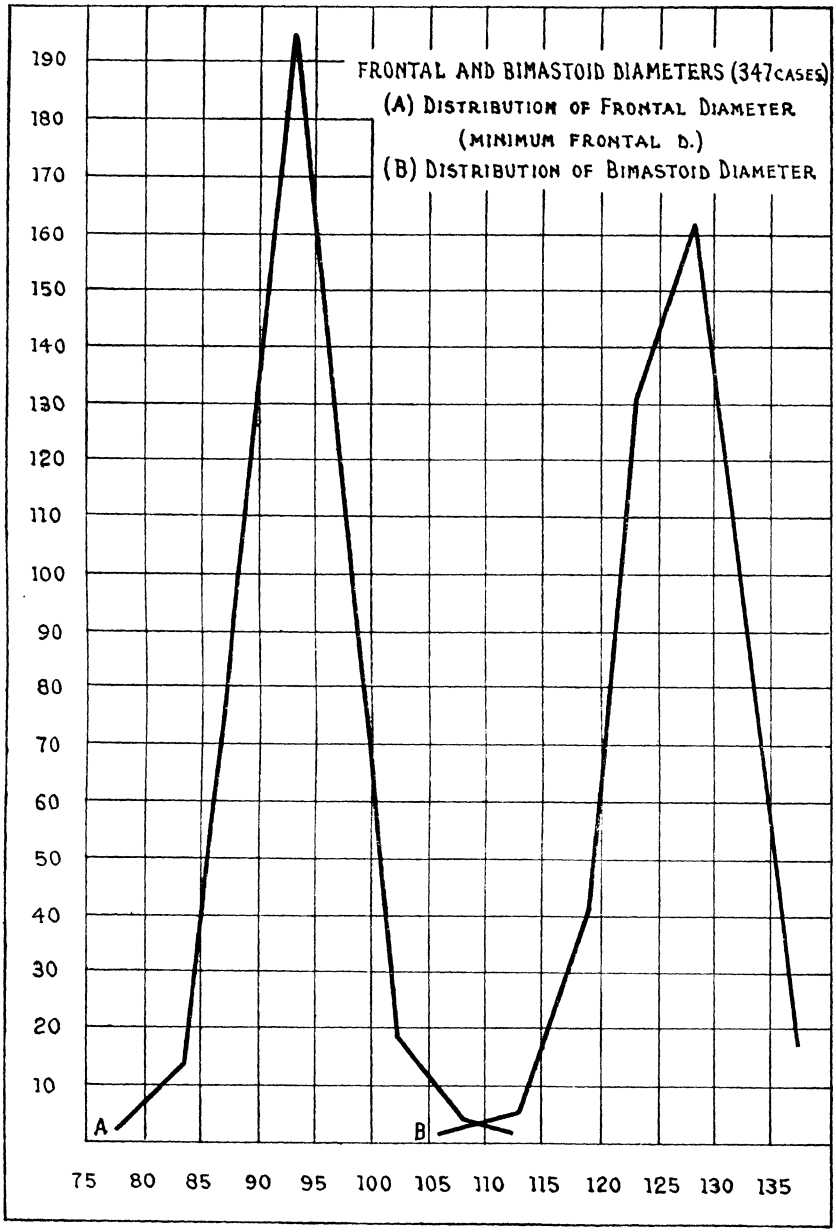

FIG. 7. Distribution of frontal and bimastoid diameters. A, minimum frontal diameter: Mean, 95.4 ± 0.14; standard deviation, 4.55 ± 0.10. B, bimastoid diameter: Mean, 122.5 ± 0.22; standard deviation, 6.8 ± 0.15.

TABLE 50.—*Frequency distribution of minimum frontal diameter of the cranium in Filipinos (437 male cases).*

Frontal diameter.	Group average.	Frequency.	Per cent.
mm.	*mm.*		
75–80	78.0	1	0.2
80–85	84.0	12	2.7
85– 90	88.5	93	21.3
90– 95	93.0	194	44.4
95–100	97.3	115	26.3
100–105	102.4	19	4.4
105–110	108.0	2	0.5
110–115	112.0	1	0.2
		437	100.0

Female.—The mean minimum frontal diameter in the female is 90.8 ± 0.19; the maximum is 97 millimeters and the minimum 85 millimeters, showing a difference of 12 units. The list of distribution of the frontal diameter in the female is shown in Table 49. The standard deviation and the coefficient of variation for this diameter in the female are 3.54 ± 0.34 and 3.89, respectively.

BIMASTOID DIAMETER OF THE CRANIUM

Male.—The mean bimastoid diameter of the male crania is 122.5 ± 0.22. The maximum diameter is 140 millimeters and the minimum is 105 millimeters, giving a difference between the two extremes of 35 millimeters.

The frequency distribution of this diameter, which is shown in Table 51, indicates the maximum frequency to be within the intervals of 125 and 130 millimeters, including 162 cases and constituting 37.7 per cent of all the male crania. Between the diameters 120 and 130 millimeters there are included 293 cases, making 68.2 per cent. The curve of frequency distribution of this diameter is traced in fig. 7, B.

The standard deviation for this dimension is 6.8 ± 0.15, and the coefficient of variation is 5.57 ± 0.09.

Female.—The mean bimastoid diameter found in the female group is 119.4 ± 0.87, with the maximum recorded diameter of 132 millimeters and a minimum of 104 millimeters. Table 49 gives the distribution of this dimension in all the female crania in the series. The standard deviation met with is 6.2 ± 0.61, and the coefficient of variation is 5.21.

TABLE 51.—*Frequency distribution of the bimastoid diameter in Filipinos (430 males).*

Bimastoid diameter.	Group average.	Frequency.	Per cent.
mm.	*mm.*		
105-110	105.0	1	0.2
110-115	113.2	5	1.2
115-120	118.8	41	9.5
120-125	123.4	131	30.5
125-130	127.8	162	37.7
130-135	132.6	72	16.7
135-140	137.3	18	4.2
		430	100.0

COMPARATIVE STUDY OF THE AURICULAR, FRONTAL, AND BIMASTOID DIAMETERS IN THE MALE AND FEMALE AND THEIR VARIABILITIES

The mean values of the auriculobregmatic height and the minimum frontal and the bimastoid diameters in Filipinos are invariably higher in the male than in the female for the corresponding dimensions of the skull. These are shown in Table 52, together with the corresponding standard deviation and coefficient of variation of each. The difference in the minimum frontal diameter between the male and female is considerable, the mean value of this diameter is around 5 millimeters larger for the male than for the female. Only slight differences, however, are observed for the two other dimensions.

TABLE 52.—*Variability of auriculobregmatic height and of minimum frontal and bimastoid diameters in the male and female Filipinos.*

Sex.	Auriculobregmatic height.			Minimum frontal diameter.		
	Mean.	Standard deviation.	Coefficient of variation.	Mean.	Standard deviation.	Coefficient of variation.
	mm.			*mm.*		
Male	115.5	4.80±0.11	3.09±0.07	95.4	4.55±0.1	4.7±0.06
Female	113.1	4.29±0.42	3.79	90.8	3.54±0.3	3.89

Sex.	Bimastoid diameter.		
	Mean.	Standard deviation.	Coefficient of variation.
	mm.		
Male	122.5	6.8±0.15	5.57±0.09
Female	119.4	6.2±0.61	5.21

As seen from Table 52 the auriculobregmatic height is absolutely a little more variable in the male than in the female, although relatively it is slightly less variable in the male.

In the frontal diameter the male group shows both absolutely and relatively a greater variability than the female. In the bimastoid diameter the same relation of variability exists between the two sexes.

COMPARATIVE STUDY OF AURICULAR HEIGHT AND FRONTAL AND BIMASTOID DIAMETERS IN VARIOUS RACES

No detailed comparison of any great importance can be followed for these dimensions between various races as very few references are locally available. The few data we were able to collect are presented here in tabulated form for just a cursory view of their comparative standing. In Table 53 are shown the auricular height and frontal diameter of some Asiatic races reported by various authors.

TABLE 53.—*Auriculobregmatic height and minimum frontal diameters of the cranium of some Asiatic races (males).*

Race.	Auriculobregmatic height.		Race.	Minimum frontal diameter.	
	Number.	Mean.		Number.	Mean.
		mm.			*mm.*
Hindu	10	111.4	Burmese B	8	89.7
Tibetan A	17	113.2	Burmese C	8	90.4
Tibetan B	15	115.5	Hindu	10	92.4
Burmese B	7	116.7	Tibetan A	17	92.6
Burmese C	8	116.9	Malayan	77	93.4
Burmese A	44	117.7	Chinese	49	93.9
Malayan	77	118.1	Tibetan B	15	94.3
Chinese	38	119.2	Burmese A	44	94.3
Ainu	88	119.3	Ainu	88	96.2
Filipino	438	115.5	Filipino	438	95.4

The auriculobregmatic height of the Filipinos is found to be relatively less than that of the majority of the Asiatic races listed. It is significantly interesting that the Hindus have the least, and the Ainus have the greatest auricular height.

The minimum frontal diameter of the Filipinos is the second largest of those in the list, coming after that of the Ainus. The shortest minimum frontal dimension belongs to the Burmese of group B.

Table 54 is a list of some European and African races with the dimensions of the skull of Filipinos included. It is somewhat striking that the minimum frontal diameter of the Filipinos is found to be comparatively shorter than that of any of the European races included in the list. This is observed to be true for both male and female Filipinos. The shortest minimum frontal diameter among the Europeans is that of the French group, as represented by military men; the longest is that of the old Bavarians of central Europe.

TABLE 54.—*Auriculobregmatic height and minimum frontal diameters of the cranium of some European and African races.*

Race.	Auriculobregmatic height.		Minimum frontal diameter.	
	Male.	Female.	Male.	Female.
Europe:	*mm.*	*mm.*	*mm.*	*mm.*
French (soldiers)	112.8	--------	96.2	--------
Wurtenberg (Germany)	--------	--------	97.1	93.9
Greifenberg (Austria)	--------	--------	97.6	93.5
Laas (Northern Italy)	--------	--------	98.0	97.0
English (Whitechapel)	114.5	109.2	98.0	93.1
Walser (Austria)	--------	--------	100.0	97.0
Danis (Switzerland)	--------	--------	100.0	96.5
Bavarian Foothills	--------	--------	100.6	94.6
Old Bavarian	--------	--------	103.7	96.3
Africa:				
Modern Egyptian (Cairo)	116.0	109.2	94.0	91.7
Modern Negro (North Africa)	115.0	--------	95.9	--------
Filipino	115.5	113.1	95.4	90.8

SUMMARY

The number of cases that this report represents reaches a total of 461 crania, 23 of which are females and 438 males. These crania are of present-day Filipinos of rather low intellectual and social strata. These were natives of different regions of the Philippines who collectively have a coincident geographic distribution closely in direct proportion to the actual thickness of population of the several regions of the Archipelago. These crania were all prepared in the Department of Anatomy of the University of the Philippines from known cases with definite records and identifications, from bodies that came to the City Morgue of Manila from various charity institutions and hospitals, mostly however from Bilibid Hospital of the Insular penitentiary. In this series 30 per cent are within the ages of

26 and 35 years, and 53 per cent are between 21 and 40 years. The average age of the series is 41 years.

The anteroposterior diameter, or length of the cranium, has its maximum frequency at 173.1 millimeters, covering 120 cases, or 27.4 per cent of the total number of male crania. Between the lengths of 165 and 180 millimeters there are comprised 308 cases, making 70.3 per cent of the series. The mean anteroposterior diameter of the male crania is 175.5 millimeters, and that of the female is 167 millimeters. In this diameter there exists a slightly greater absolute variability in the male than in the female. The range of difference in this diameter for the different tribes of Filipinos is very narrow reaching only 8 millimeters, unlike that of the transverse diameter where the range of difference is wider, reaching 17 millimeters.

The transverse diameter, or breadth, of the cranium has its greatest frequency in the male at 142.9 millimeters, covering 148 cases and making thus 33.8 per cent of all the male series. Between the diameters of 135 and 150 millimeters there are included 350 cases, or 79.9 per cent of the total number. The mean transverse diameter in the male Filipinos is 146 millimeters, and in the female it is 138 millimeters. This diameter is slightly more variable in the female than in the male, both absolutely and relatively. As mentioned above the range of difference in this diameter for the various regional groups of Filipinos is twice as wide as that existing for the cranial length.

The cephalic, or length-breadth, index of the cranium in the male has its greatest frequency at the index of 83, comprising 207 cases, or 47.3 per cent of all the cases. The mean length-breadth index in the male is 81.8 and in the female is 82.5, showing thus a higher cranial index for the latter sex. Both absolutely and relatively, this index shows more variability in men than in women in Filipinos. This condition of greater variability in the cephalic, or cranial, index in men is found to be true also for all the races so far studied and comparatively referred to in this paper. Under the type classification of indices it was observed that the greatest frequency in the male Filipinos is within the brachycephalic type of head; this class includes 207 cases, or 47.3 per cent. The next most frequent type is under the mesocephalous, covering 131 cases, or 30 per cent of the total number of males. In the females the greatest frequency is also located in the brachycephalic type, covering more than half of all the female skulls. A survey of the cephalic indices of the different regional groups of Filipinos, as reported also

by various authors, shows that almost all of those represented fall within two types of classification—the mesocephalous (75–80) and the brachycephalous (80–85)—with the greater tendency shown towards the brachycephalic type for most of the groups reported, and that this condition is much more evident in the better-civilized class of Filipinos.

Some cursory comparisons are followed between the cranial dimensions and indices of various races of the world that are available from our local references (northern and southern Asiatics, Pacific Islanders, Australians, American whites and negroes, Eskimos and Europeans) together with those obtained from the present series of Filipinos. The results on their comparative standings are noted, and among the most important of these are the following:

There exist lesser degrees of variation in the principal dimensions of the head among the southern Asiatic races than occur among the Pacific Islanders, including the Filipinos.

The head length of the Filipinos stands within the higher values of those of the southern Asiatics, and the former have the greatest head breadth, both among the different Pacific Island races and the southern Asiatics. This, quite interestingly, means that, as far as our locally available references show, the head in Filipinos is comparatively larger than in the majority of southern Asiatic races; and that the type of head of the Filipinos is decidedly more brachycephalic than many of the neighboring races of continental Asia and of the Pacific.

The head length of the Japanese is a trifle greater than that of the Filipinos for both sexes. The head breadth, however, of the Filipinos is greater for both male and female. The cephalic index of the Japanese is consequently lower, indicating that the Filipino, regardless of sex, has a more-rounded head than the Japanese and relative figures further show that this is more particularly true between the males of the two races. Comparative data on incidences also show that there is a greater tendency in Filipinos towards hyperbrachycephaly than in the Japanese.

The relative condition of cephalic dimensions and indices in the various races compared, including the Filipinos, tends to prove quite frankly the commonly accepted consideration that women are more round headed than men in nearly all races.

The brachycephalic condition of the head in the Filipinos is surpassed by that of the Germans, who show the most-advanced type of brachycephaly among the races whose data on cephalometry have been successfully gathered by us.

In the parallel study of the degree of variation of the length-breadth index of the cranium among the Asiatic races, it was found that the Filipinos show a more variable cranial index than any of the other races listed. This condition we believe is due to the very fact that the Filipino race of to-day is considerably blended with extraneous blood and that this admixture is very much greater in degree and in extent than is found in any of the Asiatic races. In this connection it is to be mentioned that it is

hitherto the frequent assertion of various authorities in this line, that primitive or uncivilized races almost always show low variability of cephalic or cranial index.

The basilobregmatic diameter, or height of the cranium, in Filipinos has its greatest frequency at 137.8 millimeters, covering 156 cases, or 35.7 per cent of all the males. Between the heights of 130 and 140 millimeters there are comprised 65.7 per cent, and between 125 and 145 millimeters there are included 95.9 per cent. The mean cranial height for the male is 140.5 millimeters; for the female it is 132 millimeters. The males show a slightly larger absolute and relative variability in cranial height than the females.

In length-height index, or vertical index, of the cranium the greatest frequency is at 79, covering in all 22.2 per cent of all the male skulls. Between the indices of 76 and 80 there are included 43 per cent, and between 74 and 82 there are comprised 74.6 per cent. The mean length-height index for the male is 79.9; for the female it is 78.9. This cranial index is absolutely and relatively more variable in the male than in the female. In the type classification of this index in Filipinos it is under the class of high-headed kind (hypsicephalous) that the greatest frequency is found, comprising 332 cases, or 76 per cent of all the male crania. This particular finding, together with that observed for the length-breadth index classification in Filipinos, strongly substantiates the commonly admitted characterization that the Malayans are of the high-broad-headed race, hypsibrachycephalous. In reference to the females a similar condition of type distribution also exists; that is, nearly all the female skulls of our Filipino series come under the hypsicephalic type of head.

The breadth-height index of the cranium has its greatest frequency under index 96, covering 36.9 per cent of all the male crania. Between the indices 92 and 100 there are included 61.7 per cent. The mean breadth-height indices for the male and female Filipinos are 94.8 and 95.8, respectively. Under the type classification of this index the highest frequency is found under the metriocephalic type with the next greatest inclination of incidence towards the acrocephalic, or high-headed type. This finding appears to be in close consonance again with what has been already referred to in the preceding paragraphs regarding the true and correct typing of hypsibrachycephalic form of head for the Filipinos. Comparison of figures on the length-height and breadth-height indices in the two sexes in Filipinos

shows that the cranial vault of the female is slightly higher in reference to its breadth than is met with in the male, in spite of the fact that the latter has a slightly taller head from the standpoint of cranial length.

The present figures on the cranial height and length-height and breadth-height indices in Filipinos compared with those of other races, showed some interesting findings, among the most important of which are the following:

The cranial height of Filipinos, both male and female, is superior to that of some of the Pacific races cited in this paper. It is also considerably above that of the Asiatic races mentioned in our references, and compared with that of some races of central Europe, that of our series is likewise slightly higher. This very finding seems to prove emphatically the correctness of the commonly admitted assertion that the most prominent craniologic characteristic of the Malays is the high form of head they possess.

The comparative standing of the length-height index of our series with that of some Asiatics, indicates that this index is comparatively higher in Filipinos than in any of the races included in the list of Asiatics with the exception of the Hylam Chinese.

On the sagittal arc of the cranium the highest frequency is found at 366 millimeters, covering 131 cases, or 30.4 per cent of all the males. The degree of frequency between 350 and 380 millimeters is 72.3 per cent. The mean sagittal arcs of the male and female are, respectively, 370.2 millimeters and 369 millimeters. In Filipinos the males have a slightly greater variability in this arc than the females.

The greatest frequency for the transverse arc of the cranium is found at 325 millimeters, covering 145 cases, or 33.4 per cent of all the male group. Between the arcs of 310 and 330 millimeters there are included 266 cases, or 61.2 per cent of all the males. The mean transverse arcs in the male and female are, respectively, 320.5 and 308.6 millimeters. This arc is found to be more variable, absolutely and relatively, in the female than in the male, a condition quite the reverse of that seen for the sagittal arc.

The horizontal circumference of the cranium has the greatest frequency at about 505 millimeters, covering 127 cases and amounting to 29.2 per cent of all the male group. Between the circumferences 490 and 520 millimeters there are comprised 311 cases, or 71.6 per cent. The mean values of this circumference in the male and female are, respectively, 505.3 and 486.1 millimeters. Absolutely and relatively, the horizontal circumference of the cranium in Filipinos is slightly more variable in the female than in the male.

The comparative study of the cranial arcs and circumference of the present series with those of other races, as met with from just a mere superficial comparison of craniometric data available to us, gave the following interesting points:

The sagittal arc of the Filipinos is one of the three largest dimensions among the Asiatic races included in the list, surpassed only by those of the Ainus and the Hokien. The comparative value of the transverse arc is, however, only on the average median level of this arc in the Asiatics. The horizontal circumference of our series is also within the middle values of this circumference for the Asiatic races.

Compared with the European races the sagittal arc in Filipinos is likewise among the longest, seconding only the English of the Whitechapel races. The transverse arc and the horizontal circumference of our group fall only within the middle level of these dimensions for the European races.

The auriculobregmatic height, or auricular height of the skull, in Filipinos has its maximum frequency at 118 millimeters, covering 191 cases, or 43.8 per cent of the male group. Between the heights of 110 and 120 millimeters there are included 68 per cent. The mean values of this height for the male and female are, respectively, 115.5 and 113.1 millimeters. In this dimension of the skull the male shows a slightly greater variability absolutely, although a trifle less relatively, than the female.

The minimum frontal diameter has its highest frequency at 93 millimeters, covering 194 cases, or 44.4 per cent of the entire male crania. Between the frontal dimensions of 90 and 100 millimeters there are included 70.7 per cent. The mean frontal diameter of the male is 95.4 millimeters, and that of the female is 90.8 millimeters. Both absolutely and relatively the minimum frontal diameter in the male is more variable than in the female.

In the bimastoid diameter of the skull the greatest frequency is found at 127.8 millimeters, covering 162 cases, or 37.7 per cent of all the males. Between the diameters of 120 and 130 millimeters there are included 293 cases, or 68.2 per cent. The mean bimastoid diameter of the male is 122.5 millimeters, and that of the female is 119.4 millimeters. In this diameter the male shows a greater degree of variability, absolutely and relatively, than the female.

Some of the interesting results obtained from a superficial comparison of the auricular height and frontal and bimastoid diameters of the skull obtained from our series with those reported for other races are the following:

The auricular height of the Filipinos is comparatively less than that of the majority of the races included in the list of Asiatics. The mini-

mum frontal diameter of the present series is the second largest, surpassed only by that of the Ainus of Japan.

The minimum frontal diameter of the Filipinos is found to be comparatively less than that of any of the European races listed from our references. This finding is true for both male and female Filipinos as represented by the present series under study.

Summary of cranial dimensions and indices of the Filipino crania.

438 MALE CRANIA.

Measurement.	Mean.	Maximum.	Minimum.	Standard deviation.	Coefficient of variation.
	mm.	*mm.*	*mm.*		
Anteroposterior diameter (length of the cranium)	175.5±0.69	196	156	6.84±0.49	3.34±0.09
Transverse diameter (breadth of the cranium)	146.0±0.21	171	128	6.61±0.15	3.30±0.05
Basilobregmatic diameter (height of the cranium)	140.5±0.19	157	123	5.84±0.13	4.17±0.09
Sagittal arc of cranium	370.2±0.65	415	325	13.50±0.46	3.64±0.08
Transverse arc of cranium	320.5±0.51	348	293	10.65±0.24	3.32±0.02
Horizontal circumference	505.3±0.43	544	460	13.50±0.67	2.67±0.08
Auriculobregmatic height (auricular height)	115.5±0.15	130	103	4.80±0.11	3.09±0.07
Minimum frontal diameter (breadth of forehead)	95.4±0.14	112	78	4.55±0.10	4.70±0.06
Bimastoid diameter	122.5±0.22	140	105	6.80±0.15	5.57±0.09
Length-breadth index (cephalic index)	81.8±0.16	97.6	64.4	4.88±0.11	5.95±0.12
Length-height index (vertical index)	79.9±0.12	90.2	68.4	3.86±0.09	4.82±0.10
Breadth-height index	94.8±0.15	112.7	81.4	4.75±0.11	1.08±0.08

23 FEMALE CRANIA.

Measurement.	Mean.	Maximum.	Minimum.	Standard deviation.	Coefficient of variation.
Anteroposterior diameter (length of the cranium)	167.0±0.84	183	156	6.17±0.61	3.69
Transverse diameter (breadth of the cranium)	138.0±0.78	149	127	5.62±0.56	4.07
Basilobregmatic diameter (height of the cranium)	132.0±0.72	142	119	5.20±0.51	3.93
Sagittal arc of cranium	350.8±0.72	369	327	12.30±1.22	3.50
Transverse arc of cranium	308.6±1.78	336	282	12.45±1.26	4.04
Horizontal circumference	486.1±1.92	511	458	13.72±1.36	2.82
Auriculobregmatic height (auricular height)	113.1±0.60	122	103	4.29±0.42	3.79
Minimum frontal diameter (breadth of the forehead)	90.8±0.49	97	85	3.54±0.34	3.89
Bimastoid diameter	119.4±0.87	132	104	6.20±0.61	5.21
Length-breadth index (cephalic index)	82.5±0.61	90	70	4.35±0.43	5.30
Length-height index (vertical index)	78.9±0.43	85	72	3.09±0.30	3.91
Breadth-height index	95.8±0.52	104.9	85.2	3.78	3.94

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ILLUSTRATIONS

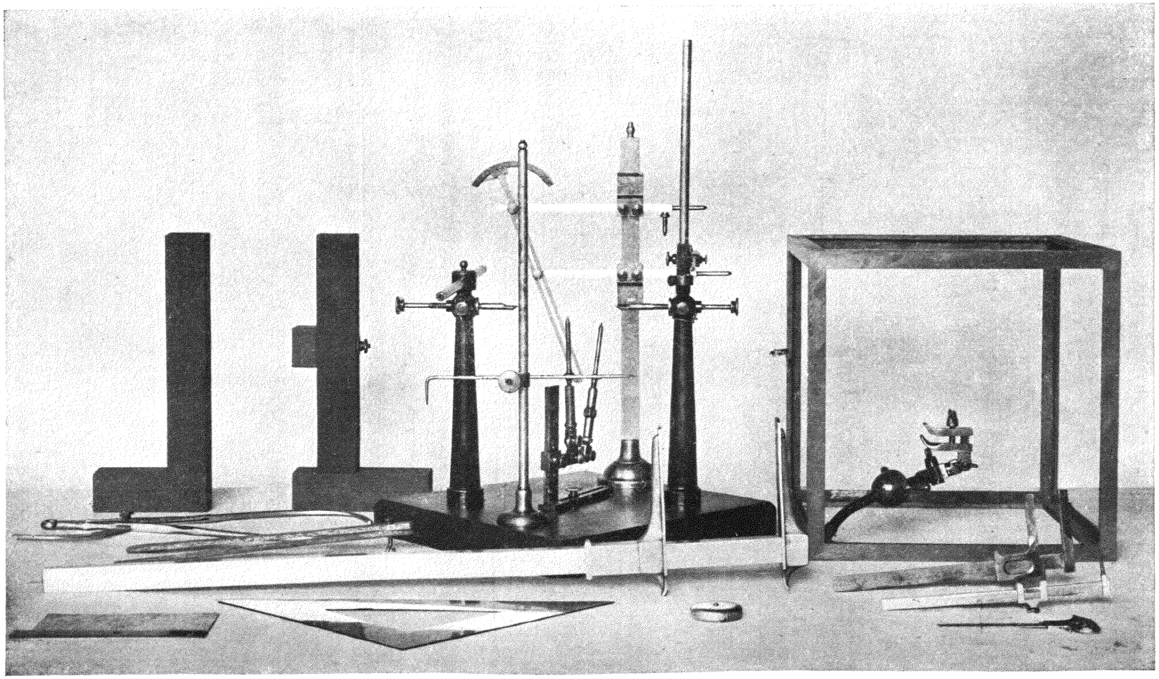

PLATE 1. INSTRUMENTS USED FOR MEASURING CRANIAL DIMENSION.

PHILIPPINE COLLEMBOLA, II

MATERIAL COLLECTED BY THE LATE CHARLES FULLER BAKER

By EDWARD HANDSCHIN

Of Basel, Switzerland

FOUR PLATES AND ONE TEXT FIGURE

Der vorliegende 2. Beitrag [1] zur Collembolenfauna der Philippinen befasst sich mit Material, das von dem leider zu früh verstorbenen Charles Fuller Baker am Mount Maquiling gesammelt worden war. Durch Aussieben von Moos und Erdproben mittels eines Berleseapparates ist ein Material zusammengekommen, wie bis jetzt noch kein zweites aus den Tropen einer Bearbeitung vorgelegen hat. Hunderte von Individuen ein und derselben Art, die in demselben enthalten waren, gestatten endlich nicht nur eine einwandfreie Umschreibung der Formen, sondern auch das Festlegen ihrer Variabilität und zudem zeigen die Funde mehr als alle andern die wirkliche Zusammensetzung einer lokalen Fauna des tropischen Urwaldgebietes. Wenn auch dem unermüdlichen Erforscher der Tierwelt der Philippinen ein Dank nicht mehr persönlich abgestattet werden kann, so sei doch dieser kleine Beitrag zu einer Fauna, der sein Lebenswerk galt, seinem Andenken in Dankbarkeit gewidmet.

Mit den bereits beschriebenen Arten, steigt die Fauna des Mount Maquiling auf 18 Formen an.

1. *Ceratrimeria maxima* Schött.
2. *Ceratrimeria pulchella* E. H.
3. *Achorutes bakeri* E. H.
4. *Proisotoma lombokensis* Schött.
5. *Isotomurus palustris* Müll. var. *balteata* Rt.
6. *Lepidocyrtus parvidentatus* Schäffer.
7. *Lepidocyrtus coeruleocinctus* sp. nov.
8. *Lepidocyrtus vestitus* sp. nov.
9. *Acanthurella lepidornata* sp. nov.
10. *Acanthurella brunnea* sp. nov.
11. *Lepidocyrtinus schafferi* Schött.
12. *Pseudoparonella orientalis* sp. nov. (Syn: *Pseudoparonella setigera* C. B.)

[1] Handschin, E., Collembola from the Philippines and New Caledonia, Philip. Journ. Sci. 30 (1926) 235.

13. *Aphysa longicornis* (Oud.) Schött.
14. *Alloscopus tenuicornis* C. B.
15. *Cyphoderus orientalis* Folsom.
16. *Arrhopalites violaceus* sp. nov.
17. *Bourletiella spectabilis* sp. nov.
18. *Dicyrtomina verrucosa* sp. nov.

Wie aus der Tabelle hervorgeht, sind 8 der aufgeführten Formen als neu für die Wissenschaft zu bezeichnen. Die übrigen bewohnen die umliegende papuanische und indo-malaiische Region.

CERATRIMERIA MAXIMA Schött, 1901.[2] Plate 1, figs. 1–3.

Die Form der Philippinen unterscheidet sich in einigen Punkten von Exemplaren, welche von Java und Sumatra zur Untersuchung vorlagen. Vor allem ist hier das Postantennalorgan nur einfach, die mittlere akzessorische Höckerreihe in der Mitte des Organs fehlt. Auch konnten nur 12–15 Tuberkel gezählt werden, welche in ihrer Beschaffenheit etwas an diejenigen von *Klaphorura* erinneren. Sie sind in der Mitte etwas eingesenkt und wölben sich an beiden Enden vor. Das Antennalorgan gleicht demjenigen von *longicornis* E. H.[3] An der Klaue finden wir einen schwachen Innenzahn, die Aussenzähne werden kaum ausgebildet. Der Mucro besitzt eine starke Dorsalrippe und breite Lamellen.

Es scheint, dass im Genus *Ceratrimeria* ein grosser Formenkreis vorliegt, dessen Arten aber wenig differenziert sind, ähnlich wie das bei *Hypogastrura* der Fall ist. Hingegen scheint mir bei den vorliegenden Tieren eine Aufspaltung nicht am Platze zu sein. Im ganzen enthielt die Sammlung 41 Individuen.

ACHORUTES BAKERI E. H., 1926.

Die Art scheint ausserordentlich häufig zu sein, waren doch 256 Tiere vorhanden, welche dieser Form zugestellt wurden. Unterschiede der Originaldiagnose gegenüber[4] konnten keine festgestellt werden. Doch muss betont werden, dass die von älteren Autoren beschriebenen Formen (*fortis* Oud. z. b. wie auch einzelne indische Arten) heute nicht mehr einwandfrei bestimmt werden können, und die Möglichkeit einer doppelten Beschreibung so besteht. Wie aber schon früher betont wurde, bestehen grosse Differenzen zwischen *bakeri* und den andern Arten der

[2] Schött, H., Apterygoten von Neu Guinea und den Sunda-inseln, Termesz. Füzetek. 24 (1901).

[3] Handschin, E., Ost-indische Collembolen III, Treubia 8 (1926) 451.

[4] Philip. Journ. Sci. 30 (1926) 236.

orientalischen Region, die in Diagnose und Abbildung festgehalten worden sind.

PROISOTOMA LOMBOKENSIS Schött, 1901. Plate 1, figs. 4 and 5.

Die Art wurde seinerzeit von Schött 1901 von den Sundainseln beschrieben. Seither ist sie nicht mehr gefunden worden. In Form, Grösse und den morphologischen Details stimmen nun die Tiere der Philippinen mit Diagnose und Figuren Schött's überein. Immerhin muss hier betont werden, dass in der Originalbeschreibung nichts über die Farbe der Tiere ausgesagt wird. Doch dürfte aus der Zeichnung zu schliessen, das Pigment körnig sein und sich netzartig über den Körper verteilen.

Dies ist bei allen vorliegenden Tieren der Fall. Nur der Ommenfleck tritt als schwarzes Feld deutlich hervor. Die Körperbehaarung ist kurz und dicht, anliegend. Abd. V und VI sind mit einander verwachsen, die Segmentgrenzen an den Seiten jedoch noch wahrnehmbar. Die Klaue ist zahnlos, der Empodialanhang mit einer starken Innenlamelle ausgerüstet. Die Mucronen sind stark gebogen, 2-zähnig, die Dentes weisen eine deutliche Ringelung auf. Länge der Tiere 0.8 bis 1 mm.

ISOTOMURUS PALUSTRIS Müll. var. **BALTEATA** Rt. Plate 1, figs. 6 to 8.

Schäffer [5] und Schött haben diese Form bereits von Neu Guinea und dem Bismarkarchipel gemeldet. Ihre Beschreibung passt auch bis auf ein Detail auf unsere Individuen. Der Empodialanhang trägt bei den vorliegenden Tieren keinen Innenzahn, sondern blos einen basalen Lappenanhang. Möglicherweise handelt es sich um eine geographische Differenzierung der Form vom Maquiling, den mehr südlichen Vorkommnissen der Art gegenüber. Ob die Form auch wirklich identisch mit den nordischen *balteata* Rt. ist, kann ebenfalls nicht entschieden werden. Ein Habitusbild mag deshalb das Aussehen der orientalischen Tiere illustrieren.

LEPIDOCYRTUS COERULEOCINCTUS sp. nov. Plate 1, figs. 9 to 11.

Diagnose.—Länge der Tiere ca. 1 mm. Die Tiere sind stark blau pigmentiert, ähnlich wie *Lepidocyrtus cyaneus.* Das Pigment ist diffus über den ganzen Körper verteilt, sammelt sich aber auf Abd. III zu einem dunkeln Bande. Auch das Ende des Abdomens und der Ommenfleck sind dunkel. Die Schuppen sind klein. Sie fehlen auf Antennen und Beinen. Von der Behaarung ist nicht viel zu bemerken, sie scheint ausgefallen zus ein.

[5] Schäffer, C., Die Collembola des Bismark-Archipels, Arch. f. Naturg. 64 (1898) 393.

Klaue mit 2 basalen, kleinen Flügelzähnen. Der Empodialanhang mit nach aussen divergierenden Kanten und abgeschrägter Innenseite ca. ½ der Klauenlänge erreichend. Das Keulenhaar ist kurz und schwach. Der Mucro ist auffallend in die Länge gestreckt, zweizähnig mit Basaldorn.

Von den zum Vergleiche der Art nahestehenden Formen scheinen *silvestris* Carp. von den Seychellen,[6] *coeruleus* Ritter [7] von Ceylon und *assimilis* Schäff. vom Bismarkarchipel zur vorliegenden nahe Beziehungen zu besitzen. Indessen muss betont werden, dass von namhaften Autoren *assimilis* als Varietät zu *cyaneus* gezogen worden ist, eine Vereinigung die für *coeruleocincta* nicht angeht. Die Beschaffenheit der Klauen, des Empodialanhanges und der Mucronen sind zu different um eine Vereinigung zu gestatten. Dasselbe gilt auch in Bezug auf *silvestris,* für welche namentlich als Hauptunterschied das eigentümliche divergieren der Empodialanhangkanten massgebend wird. Was endlich die Ritter'sche Art anbetrifft, so ist dieselbe leider ungenügend fundiert und Diagnose und Abbildungen gestatten keinen Vergleich.

LEPIDOCYRTUS VESTITUS sp. nov. Plate 1, figs. 12 and 13.

Diagnose.—Länge der Tiere 1 mm. Farbe gelb, dunkles Pigment findet sich blos im Ommenfleck und in den Antennen. Kopf und Körper sind dicht mit sehr grossen, purpurnen Rundschuppen bedeckt; Beine und Antennen sind schuppenfrei. Die Antennen sind relativ kurz und erreichen blos 1½ mal die Länge der Kopfdiagonale. Das Antennalorgan III ist vorhanden und besteht aus 2 Sinnesstäbchen in einer Grube. Klaue mit schwachen, kaum sichtbaren Innenzähnen, Empodialanhang abgestutzt. Das Keulenhaar des Tibiotarsus ist sehr dünn und so lang als der Empodialanhang. Abd. III : IV = 4 : 19. Mucro mit 2 Zähnen und Basaldorn. Apicaldorn gross, ähnlich wie bei *parvidentatus.*

Die Form ist durch die auffallende grosse und gefärbte Beschuppung leicht kenntlich und dadurch von allen mir bekannten *Lepidocyrtus*-arten unterschieden.

LEPIDOCYRTUS PARVIDENTATUS Schäff., 1898. Plate 1, fig. 14; Plate 2, fig. 15.

Schon im ersten mir übermittelten Materiale fand sich die vorliegende Art vor. Erneute Untersuchungen an einem gröss-

[6] Carpenter, G. H., The Apterygota of the Seychelles, Proc. R. I. Acad. 33 (1916).

[7] Ritter, W., Neue Thysanuren und Collembolen von Ceylon, Ann. Wien. Hofmus. 24 (1910).

eren Materiale erlauben nun einige Punkte richtig zu stellen. Zugleich wurde aber ein neues Charakteristikum aufgefunden, das entweder als Merkmal einer Untergattung aufzufassen ist, oder aber es stellt sekundäre Geschlechtsmerkmale dar. Nach morphologischen Befunden bei andern Tieren, scheint mir eher das Erstere zuzutreffen, doch kann ein definitiver Entscheid an totem Materiale nicht gefällt werden.

Länge der vorliegenden Tiere 2.5 mm. Grundfarbe gelblich mit starken Pigmenteinlagerungen auf allen Segmenten, aber gegen das distale Ende von Abd. IV bedeutend verstärkt. Pigment in Körnerform. Vorderrand von Abd. IV hell, mit parallelen Streifen. Th. II und III fast pigmentfrei. Am Kopfe ist nur die Stirn mit blauer Farbe geziert und der Ommenfleck ist schwarz. Die Antennen sind ganz blau. An den Beinen bemerken wir Zunahme des blauen Pigmentes nach hinten. An Bein I nur Coxen und Subcoxen, an Bein II und III auch Trochantere und Femora ganz, die Tibien nur teilweise und diffus bläulich. Das Manubrium ist ebenfalls blau. Ant. IV ist ungeringelt, ein Endkolben konnte nich beobachtet werden. Th. II stark vorragend, den Kopf teilweise bedeckend. Der ganze Körper reich und dicht mit relativ kleinen, rundlich-ovalen Schuppen bedeckt. Schuppen finden sich auch auf Ant. I-III und den Beinen. Die Klaue ist lang und schlank. Sie besitzt 2 Innenzähne und stark entwickelte Pseudonychien. Der Empodialanhang ist lang lanzettich, schmal, innen nicht abgestutzt und überragt den obern Klauenzahn. Das Keulenhaar ist so lang als der Empodialanhang. Die Dentes tragen an ihrer Abtrennungsstelle vom Manubrium einen grossen zahnartigen Anhang. Der Mucro besitzt einen sichelförmig gebogenen Apicalzahn und einen kleinern basalständigen Antapicalzahn der vom Basaldorn überragt wird.

Der dentale Blockdorn erinnert stark an das Auftreten kleinerer Dornen bei der Gattung *Acanthurella,* welcher ich *parvidentatus* auch annähern möchte. Die Art ist ja auch im Auftreten von Schuppen an den Beinen und Antennen von den vorherigen stark unterschieden, und dies ist einer der Hauptgründe, welcher eher für eine Abtrennung von *Lepidocyrtus* sprechen würde, da bei den eigentlichen Acanthurellen die Schuppen sich in ähnlicher Weise ausbreiten. Sekundäre Gerschlechtscharaktere an Manubrium und Dentes würden wir aber erst von *Orchesella* her kennen, also nur von einer weit entfernten Familie.

Ferner ist ein Unterschied gegenüber *parvidentatus* vom Bismarkarchipel und den ersten Tieren der Philippinen hervorzuheben. Die vorliegenden Exemplare zeichnen sich durch ihre Pigmentierung aus welche den Tieren nach der Originaldiagnose fehlt. Da aber gerade bei den *Lepidocyrtus*-arten die Farbe sehr stark wechselt und dunkelblaue und helle Tiere nebeneinander in einer Art zu finden sind, ist eine Trennung aus diesem Grunde nicht angezeigt.

ACANTHURELLA BRUNNEA sp. nov. Plate 2, figs. 16 to 19.

Diagnose.—Länge der Tiere 2 bis 3 mm. Farbe gelbbraun bis orange. Alle sind ausserordentlich dicht mit grossen, runden, braunen Schuppen bedeckt, die auch auf den Beinen und den Antennen basal anzutreffen sind. Ant. I distal, Ant. II bis IV ganz blau. Ommenfleck schwarz. Buccalteile und Stirn blau bereift, die Tibiotarsen sind bläulich. Die Behaarung ist namentlich an den Extremitäten hervortretend. Klaue schlank, mit 2 Innenzähnen-Aussenzahn basisständig. Empodialanhang ¾ der Klauenlänge erreichend, lang, schmal, seine 2 Rippen nähern sich an der Spitze, die Kante ist also nicht abgeschnitten. Keulenhaar normal ausgebildet, ihm opponiert eine nackte Spitzborste. Mucro wie bei *Lepidocyrtus* mit 2 Zähnen und einem Basaldorn. Furca an der Ansatzstelle der Dentes auf denselben mit 2 grossen, abstehenden, dornartigen Lamellen, sonst ohne weitere Bedornung. Dentes geringelt; Ringelung nicht abgesetzt.

Bei einem kleinen entschuppten Tiere findet sich eine leichte bläuliche Pigmentierung des Bauches und der Beine.

Durch das Auftreten der eigentümlichen Dentesbewaffnung nimmt die vorliegende Form eine absolute Sonderstellung unter den *Acanthurella*-arten ein.

ACANTHURELLA LEPIDORNATA sp. nov. Plate 2, figs. 20 to 23.

Diagnose.—Länge bis 2 mm. Farbe gelblich, Körper mit grossen, ovalen Schuppen bedeckt, die auf demselben eine charakteristische Zeichnung bilden. Die Schuppen des Dessins dunkelviolett, die übrigen hyalin. Die Dentes sind nur dorsal beschuppt, die Beine und Antennen sind schuppenfrei. Antennen vom II. Gliede an distal dunkelblau. Ommenfleck dunkelblau mit 8 Ommatidien jederseits. Zwischen den Ommenflecken ein trapezförmiger Schuppenfleck. Dunkle Schuppen jeweilen als Fleck an Th. II, median, 2 bis 3 Reihen am Hinterrand von Th. III, Abd. I und Abd. III. Auf Th. II und Abd. I ist die letzte Reihe jeweilen in der Mitte durch helle Schuppen unter-

brochen; Abd. III nur mit einer Reihe. Auf Abd. IV finden wir eine Reihe am Vorderrand und eine solche am Hinterrand, Beide sind durch Längsbinden verbunden, sodass eine quadratische Figur gebildet wird. Einzelne Schuppen markieren die hintern Seitenecken von Th. II bis Abd. I. Die Haare treten besonders an den Extremitäten hervor. Sie sind gefiedert. Abd. III : IV = 8 : 24. An Ant. III finden wir ein normales Antennalorgan. Klaue mit 3 Innenzähnen. Empodialanhang mit stark divergierenden Kanten und schräg abgestutzter Innenseite. Das Keulenhaar erreicht nicht ganz Klauenlänge. Die Dentes sind geringelt; der geringelte Teil geht langsam in den Mucroteil über. Mucro 2 zähnig mit Basaldorn. Basis der Dentes mit 4 starken, nach innen gerichteten Zähnen.

Charakteristische, durch die Dentalbewaffnung, Beschaffenheit der Empodialanhänge und das auffallende Schuppenkleid umschriebene Art.

LEPIDOCYRTINUS SCHÄFFERI Schött, 1901. Plate 3, figs. 24 to 27.

Die bis jetzt von Neu Guinea (Berlinerhafen) und der Insel Seleo bekannte Art fand sich in typischen Individuen vor.

Ihre Länge beträgt ca. 2 mm. Die Farbe ist gelblich. Der Kopf und die Sternite des Thorax samt den Coxen sind orange. Der Ommenfleck ist schwarz, desgleichen der Frontalocellus. Th. I mit Streifen auf den Subcoxen schwarz. Subcoxen und Coxen von Bein II und III mit dunkeln Flecken. Schwarz sind ferner eine Hinterrandbinde an Abd. II und das ganze Tergum, von Abd. III bis Abd. IV weist nur 2 kleine Flecken an der hintern Ecke auf. Die Antennen sind violett und dunkeln von Ant. II distal immer mehr ein. Die Tiere sind dicht bräunlich beschuppt. Die Schuppen sind oval, fein skulpturiert und treten namentlich auf Abd. IV stark hervor. Behaarung stärker auf den Extremitäten. Ommen 8 jederseits. Ant. IV geringelt, mit retraktilem Endkolben. Klaue mit 3 Innenzähnen. Empodialanhang schmal, nach aussen schräg zugespitzt. Keulenhaar so lang als die Klaue. Der Mucro ist falciform, die Dentesberingelung bricht plötzlich ab, sodass ein langer Mucroteil der Dentes entsteht. Abd. III : IV = 11 : 35.

PSEUDOPARONELLA ORIENTALIS sp. nov. Plate 3, figs. 28 to 34.

Syn. *Pseudoparonella setigera* C. B. (Handschin, 1926).

In meinem ersten Aufsatze über die Collembolen der Philippinen wurde fälschlicherweise die vorliegende Art mit *Pseudoparonella setigera* Börn. identifiziert. Die Form der Philippinen gleicht nun in mancher Hinsicht den westlichen Formen von

setigera aus Sumatra und Java. Wesentliche Unterschiede liegen jedoch in der schwachen, blauen Pigmentierung der Form, die so constant auftritt—es wurden ca. 400 Individuen untersucht—dass eine Abtrennung angezeigt erscheint.

Diagnose.—Länge der Tiere bis 2 mm. Farbe gelblich, dicht braun beschuppt. Schuppen rundoval, breit, jedoch nicht so stark verbreitert wie bei *setigera.* Behaarung nur an den Extremitäten hervortretend. Haare plumös. Ommenfleck schwarz, desgleichen ein sich verbreiternder Streif von den Wangen zum Hinterkopf. Seiten von Th. II dunkel, ebenso ein Fleck auf den Subcoxen und Coxen von Bein II und III. Antennen vom Ende von Ant. II zur Spitze dunkler werdend. Antennen etwa solang als der Körper. Ant. IV leicht geringelt. Ant. III mit 2 Sinnesstäbchen zwischen 2 langen Schutzborsten. Körper schmal; Th. II weit vorgezogen. Der Habitus erinnert dadurch stark an *Lepidocyrtinus.* Abd. III : IV ca. 1 : 6. Klaue mit 3 Innenzähnen, Empodialanhang mit innerer zahnartiger Ecke, an Bein I und II etwa ⅓, and Bein III ca. ⅔ der Klauenventralkante erreichend. Das Keulenhaar ist lang und erreicht die Klauenspitze. Trochanteralorgan stark ausgebildet aus einer Flur von verschieden langen, senkrecht abstehenden Borsten bestehend, deren Länge von aussen nach innen stark abnimmt. Am Femur finden wir neben einer Reihe dornartiger Borsten eigentümliche, kolbenartige, bewimperte Haare, die Schött auch für seinen "*Bromacanthus*" geschildert hat. Die Dentes besitzen eine vollständige Dornenreihe, die vor dem Mucro ihren Abschluss findet. Der Mucro ist klein und plump. Er besteht aus 2 hakenartigen Zähnen und wird von den langen, plumösen Dentalborsten überragt.

Zu Vergleichszwecken wurden 300 Individuen Ausgemessen und zwar

1. nach der relativen Länge der einzelnen Antennenglieder (4 Masse)
2. die Länge des Kopfes (Diagonale)
3. die Länge des Körpers
4. die Länge der einzelnen Körpersegmente (8 Masse)
5. die Länge der Tibien (3 Masse) und
6. die relative Länge der Furcalteile (2 Masse). Total also 19 Masse.

Von diessen bieten nun besonders die relativen Masszahlen von Abd. III : IV und die relative Körpergrösse engere Beziehung und lassen in erster Linie einen Vergleich zu. Wie schon bei frühern Messungen an Lepidocyrtusarten zeigte es sich, dass das Verhältnis von Antenne: Kopfdiagonale keinen systematischen Wert besitzen kann, und zwar aus dem einfachen Grunde,

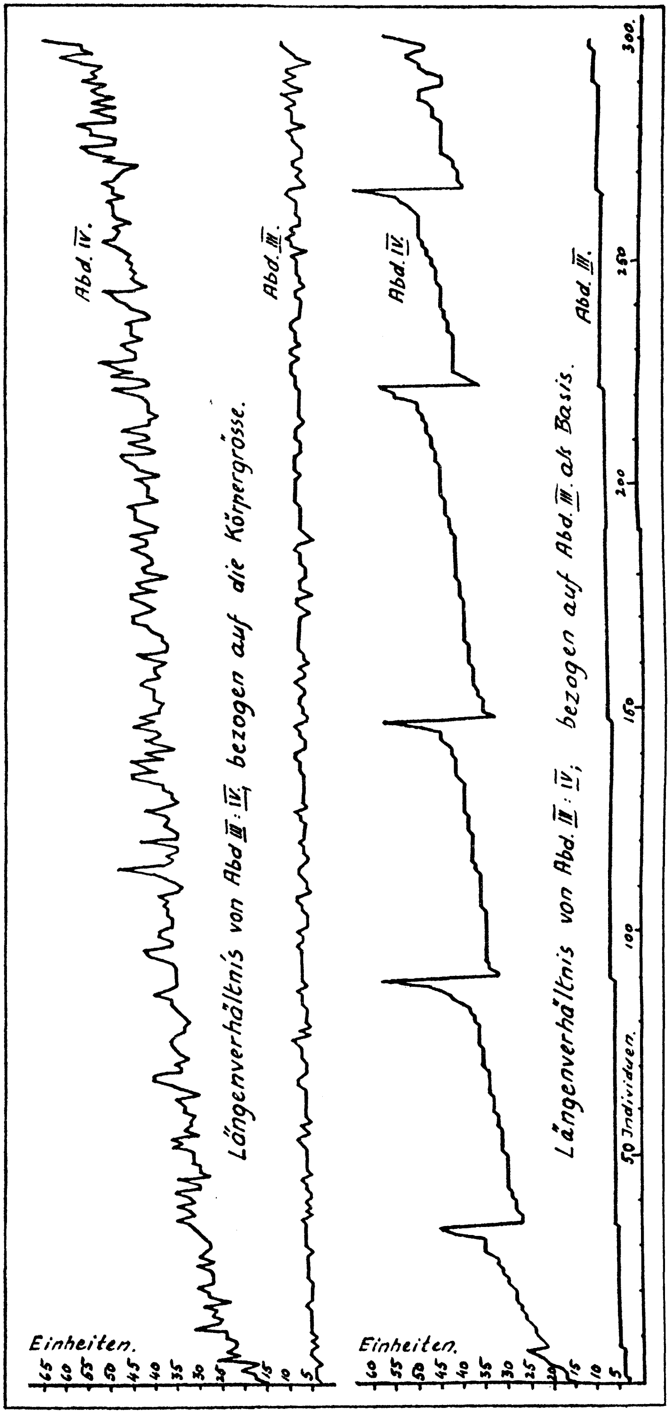

FIG. 1. Relation of length of abdomen to size of body.

weil hier die Antenne zu leicht Verstümmelungen ausgesetzt ist und die Masse sich bei einer Regeneration zu stark verändern. Es mag deshalb genügen, die morphologischen Eigenschaften derselben festzuhalten und ihre Länge auf ungefähre Körperlänge zu präzisieren. Beine und Furka regulieren die Lokomotion. Mit dem Wachstum der Tiere nimmt auch ihre Länge zu. Dabei besitzt aber nur die Furca nähere Beziehungen zur Ausbildung des Abdomens, da ihre Muskulatur im IV Abdominalsegment inseriert. Das Längenverhältnis von Abd. III : IV bleibt also als wichtigstes Mass allein bestehen und zwar als einfaches Verhältnis oder aber in Bezug auf die Rumpflänge. (Spitze von Th. II bis Ende Abd. VI.). Je nachdem wir auf die Körperlänge Bezug nehmen oder nicht resultiert eine andere Kurve, deren eine Darstellung, Abd. III : IV, uns die direkten Vergleichswerte in Bezug auf die Länge des Abd. III als Einheit bezogen darstellt, oder aber auf die Körpergrösse bezogen die direkte Grössenordnung der Tiere wiedergibt.

Beide Kurven gehen vom gleichen Punkte aus, der kleinsten vorliegenden Form, und enden bei der grössten. Während aber im erstern Falle, bei der Einordnung nach der Grössenordnung des Abd. III (Einheit) ein Sortieren nach den Grösseneinheiten von Abd. IV erfolgt, also die Kurve für Abd. III graduell ansteigt, zeigt innerhalb jeder Grössenordnung von Abd. III Abd. IV sich wiederhohlende Schwankungen von einem Minimum zu einem Maximum in sinuider Form, ähnlich einer Wachstumskurve. Beide extremen Werte liegen oft weit über dem Durchschnitt, doch ist das Bild wie gesagt für jede Grössenkategorie ein ähnliches. Sobald wir nun aber auf die Körpergrösse Bezug nehmen, beginnt auch die Kurve für Abd. III Schwankungen aufzuweisen, die sich nur langsam im höhern Ansteigen der einzelnen Werte für den Körper aufwärts bewegt. Gleichsinnig schwankt natürlich die Kurve für Abd. IV in weiten Amplituden unregelmässig auf und ab, im ganzen Durchschnitt aber auch sich in eine einheitliche sinuide Kurve einordnend.

Es scheint nun, dass mit dem ersten beschrittenen Wege die Veränderlichkeit der einzelnen Grössenkategorien festgehalten wurde. Wenn Tiere einer Generation sich häuten, so werden unter denselben bereits bestimmte Grössenunterschiede auftreten, welche durch die Maxima und Minima der einzelnen Teilabschnitte dargestellt werden. Das wiederhohlt sich natürlich für jeden weiteren Teilabschnitt, der einer Häutungsstufe entsprechen dürfte. Junge Tiere waren wenig zahlreich vertreten, was das sehr rasche Ansteigen erklären vermag. Da die Col-

lembolen sich nach erlangter Geschlechtsreife weiterhäuten, dabei aber mit dem Altern immer rascher eliminiert werden, werden mit der Grössenzunahme der Formen, die Individuenzahlen immer kleiner und gegen das Ende der Kurve hin nehmen wir wiederum ein stärkeres Ansteigen wahr. Beim Beziehen der Verhältniszahlen auf die Körpergrösse verwischen wir aber die Unterschiede die in den einzelnen Grössenkategorien auftreten mögen und haben nur den schwankenden Gegensatz von gross und klein vor uns, der durch die auf und absteigende Zickzacklinie dargestellt wird. Kleinste Tiere besitzen noch in Abd. III : IV ein Längenverhältnis von 1 : 4, grosse hingegegen weisen ein solches von 1 : 6 auf.

Es mag hier beigefügt werden, dass die von Schött aus Borneo beschriebene *Bromacanthus handschini* Schött[8] ebenfalls zu *Pseudoparonella* zu zählen ist. Schött ist bei seiner Diagnose auf die Beschreibungen seiner *setigera* Börn. (1906), *appendiculata* (1917), und *incerta* Handschin 1925 gar nicht vergleichsweise eingetreten. Mucronenbeschaffenheit und Dentalbedornung, Schuppenstruktur sind nun bei den erwähnten Arten annähernd die gleichen. Der Unterschied von *Bromacanthus* gegenüber den erwähnten Arten beruht einzig auf der Mehrspitzigkeit der Dentaldornen. Auf diesem Merkmale allein können wir aber eine Abtrennung zu einem neuen Genus nicht vörnehmen, es müsste dann aus gleichem Grunde *Tomocerus minor,* die ebenfalls mehrspitzige Dornen auf den Dentes besitzt, vom Genus als selbstständig losgelöst werden. *Pseudoparonella setigera, handschini,* und *orientalis* dürften in die gleiche Gruppe gehören aber durch räumliche Sonderung und Lokalisation eigene Wege der Entwicklung eingeschlagen haben.

APHYSA LONGICORNIS (Oud.) Schött, (1891) 1903.

Etwa 200 Individuen wurden durchgesucht und verglichen. Sie stimmen alle mit Exemplaren von Java und Sumatra überein. Dabei ist besonders die ausserordentliche Konstanz der Pigmentierung zu betonen. Bei allen Tieren war die gleiche, relativ schwache Färbung vorhanden ohne irgend welche Tendenz zur Herausbildung hellerer oder eingedunkelter Individuen zu zeigen. Es mag dies, wie auch der Fall von *Pseudoparonella orientalis* zeigen, dass der eigentliche Charakter der Zeichnung für die Unterscheidung der Formen doch einen nicht zu unterschätzenden Wert für die Systematik besitzen kann.

[8] Schött, H., Collembola from Mount Omrud and Mount Dulit in northern Sarawak, Sarawak Mus. Journ. 3 (1927).

ALLOSCOPUS TENUICORNIS Börn., 1906.[9]

Die bis jetzt nur von Java und Sumatra bekannt Form liegt in gleicher Ausbildung von den Philippinen vor. Die Tiere fallen sofort durch das rötlich pigmentiert einzige Omma und bei genauer Betrachtung durch die basale Dentalbedornung auf.

CYPHODERUS ORIENTALIS Folsom, 1924.

1924 hat Folsom[10] einen *Cyphoderus orientalis* beschrieben der von Jacobson auf Sumatra gefunden wurde. Er ist kenntlich an seinen 3 endständigen Zähnen am Mucro und der starken Klauenbezahnung. Die beiden Basalzähne sind Flügelartig entwickelt, während der Innenzahn stark zurücktritt. Ebenso trägt der Empodialanhang einen grossen flügelartigen Aussenzahn. Die Typen wurden aus einem Termitennest beschrieben. Leider liegen keine genauern Fundortsumschreibungen vom Mount Maquiling vor, doch ist es wohl möglich, dass es sich bei den Tieren von den Philippinen ebenfalls um Inquilinen irgend einer socialen Insektenform handelt. Sie stimmen mit Diagnose und Zeichnungen Folsom's völlig überein.

ARRHOPALITES VIOLACEUS sp. nov. Plate 4, figs. 35 to 37.

Diagnose.—Länge der Tiere 1 mm. Farbe dunkelblau, auf Thorax und Abdomen proximal sind die Segmentgrenzen durch feine weisse Linien angedeutet. Hell sind die Furca und die Tergite der letzten Abdominalsegmente. Beine und Fühler sind heller als der Körper, doch ebenfalls wie dieser pigmentiert Ommenfleck schwarz. Die Behaarung ist kurz und spärlich. Ant. IV ist sekundär geringelt. Die Klaue ist zahnlos, der Empodialanhang mit einem gebogenen, gekeulten Endfilament versehen. Der Rand der Mucronen ist scharf gekerbt-gezähnt.

BOURLETIELLA SPECTABILIS sp. nov. Plate 4, figs. 38 to 43.

Diagnose.—Grösse 1.5 mm. Farbe gelblichweiss mit dunkelblauem Pigment. Dieses als 2 diffuse Querbinden auf dem Vorderkopf und über die Schnauze. Grosse blaue Pigmentmassen auf dem vordern Rückenteil, dorsal-median offen, nach hinten mit schräger, schmaler sich nähernden, in der mitte ebenfalls offenen Binde. Hinterer Abdomenteil mit breiter dunkler

[9] Borner, C., Das System der Collembolen, Mitt. Nat. Hist. Müs. Hamburg 23 (1906).

[10] Folsom, T. W., East Indian Collembola, Bull. Mus. Comp. Zoolog. 65 (1924).

Querbinde. Abd. V und VI mit kleinen lateralen Flecken und linienförmiger Strich. Die Antennen sind blassblau, Ommen tief blauschwarz, desgleichen die herzförmige Pigmentmasse des Frontalocellus. Ant. I : II : III : IV = 3 : 6 : 8 : 17. Ant. IV sekundaär in 7 Ringel aufgeteilt. Antennalorgan III typisch aus 2 Sinnesstäbchen mit Schutzborsten. Das Endglied mit retraktilem Endkolben. Die Behaarung ist relativ spärlich, auffallend nur am Ende des Abdomens und den Dentes. Am Abdomen jederseits 2 lange Bothriotriche. Genitalborste des Weibchens einfach, fast so lang als der Mucro. Klaue und Empodialanhang einfach, zahnlos. Tibiotarsus mit 3 anliegenden Keulenhaaren. Mucro kahnförmig, zahnlos mit innerer Lamelle, Mucronalborste fehlt.

DICYRTOMINA VERRUCOSA sp. nov. Plate 4, figs. 44 to 48.

Diagnose.—Länge bis 2 mm. Farbe gelblich mit violetten und dunkelblauen Zeichnungen. Einheitlich violett sind die Antennen und Beine, erstere gegen das Ende hin eindunkelnd und dunkelblau werdend. Beine proximal dunkler. Pigment dabei hauptsächlich auf den lateralen Partien, Innenseiten hell. Furca nur schwach bläulich. Ommenfleck klein, schwarz. Occiput, Wangen und Schnauze diffus blau-violett, dunkler blos auf der Stirn zwischen den Antennen. Körper vorne flach, gegen den Anal-Genitalhöcker eigentümlich stark höckerartig in die Höhe gezogen und mit behaarten Warzen versehen. Hinterseite dieses Höckers dunkelblau, ebenso ein hufeisenförmiger Fleck auf demselben. Auf den Seiten des Körpers nach vorne geöffnete, heller werdende U-förmige Binden; 2 Fleckenpaare dorsal frei, desgleichen auf den Seiten. Abd. V dorsal, VI ganz dunkel. Ant. I : II : III : IV = 5 : 30 : 35 : 5. Ant. IV klein, aussen mit Quirlständigen Borsten. Praeapical mit kleinem Endkolben. Ant. III mit stark vorstehenden Borstenansatzstellen. Sinnesorgane konnten keine wahrgenommen werden. Auffallend gross sind die Gelenkzapfen zwischen Ant. I und II. Behaarung spärlich und nur auf den Extremitäten und dem Abdomenende hervortretend. Abd. III mit Dornen, zwischen denen lateral auf Warzen die Bothriotriche stehen. Abd. IV mit langen Macrochaeten. Klaue mit Tunica, diese mit zwei Paaren lateraler Zähne. Klaue mit 2 Innenzähnen. Empodialanhang mit zahntragender Ecke und Innenzahn an der Abgangsstelle des Endfilamentes. Dieses ungekeult. Mucro

lang, schmal mit fein gekerbten Rändern. Mucronalzähne rund, von verschiedener Grösse.

Von den 18 bis jetzt auf den Philippinen aufgefundenen Arten sind 10 noch nicht ausserhalb des Gebietes angetroffen worden. Es sind dies:

Ceratrimeria pulchella E. H.
Achorutes bakeri E. H.
Lepidocyrtus coeruleocinctus sp. nov.
Lepidocyrtus vestitus sp. nov.
Acanthurella lepidornata sp. nov.
Acanthurella brunnea sp. nov.
Pseudoparonella orientalis sp. nov.
Arrhopalites violaceus sp. nov.
Bourletiella spectabilis sp. nov.
Dicyrtomina verrucosa sp. nov.

Vom Bismarkarchipel und Neu Guinea her kennen wir:

Isotomurus palustris Müll. var. *balteata* Rt.
Lepidocyrtus parvidentatus Schäff. und
Lepidocyrtus schäfferi Schött.

Isotomurus palustris-balteata ist nach ihrem Namen zwar eine nordische Form, doch ist meines Erachtens die Identität mit *balteata* Rt. noch zu erweisen und der cosmopolitische Charakter deshalb in Frage gestellt. Als westliche Formen, welche auf einzelnen der Sundainseln angetroffen worden sind, erwähne ich blos

Proisotoma lombokensis Schött (Lombok) und
Cyphoderus orientalis Folsom (Sumatra).

Die drei letzten Arten

Ceratrimeria maxima Schött.
Aphysa longicornis (Oud.) Schött und
Alloscopus tenuicornis Börner.

scheinen über die ganze orientalische Region weit verbreitet zu sein.

Was nun die Verwandtschaftsbeziehungen der endemischen Formen anbetrifft, so schliesst sich *Ceratrimeria pulchella* eng an die malaiisch-papuanische *maxima* Schött an, differenziert sich aber von dieser wie *longicornis* als westliche Art. *Pseudoparonella orientalis* hat in *Pseudoparonella handschini* Schött und *setigera* Börner von den Sundainseln ihre nächste Verwandte, scheint daher eher westlichen Ursprunges zu sein, das gleiche dürfte von *Achorutes bakeri* gelten, die sich an *fortis* Oud. und *zehntneri* E. H. von Java anschliesst. Die übrigen Formen,

speziell die Lepidocyrtusformen sind noch zu wenig analysiert um weitere Schlüsse zu gestatten. Doch ist z. B. sowohl *Acanthurella* als *Alloscopus* von den Malediven an über den ganzen Archipel anzutreffen.

Es scheint demnach die Collembolen-Fauna der Philippinen soweit sie aus diesem Fragment zu beurteilen ist, einen typischen Mischcharakter zu besitzen an welchem westliche, indo-malaiische Elemente ebenso starken Anteil haben als die papuanischen.

ILLUSTRATIONS

PLATE 1

PLATE 2

PLATE 3

PLATE 4

FIG. 35. *Arrhopalites violaceus* sp. nov.; claw of first leg.
36. *Arrhopalites violaceus* sp. nov.; claw of third leg.
37. *Arrhopalites violaceus* sp. nov.; mucro.
38. *Bourletiella spectabilis* sp. nov.; right aspect.
39. *Bourletiella spectabilis* sp. nov.; dorsal aspect.
40. *Bourletiella spectabilis* sp. nov.; sense organ of third segment of the antenna.
41. *Bourletiella spectabilis* sp. nov.; claw.
42. *Bourletiella spectabilis* sp. nov.; mucro.
43. *Bourletiella spectabilis* sp. nov.; appendix analis.
44. *Dicyrtomina verrucosa* sp. nov.; right aspect.
45. *Dicyrtomina verrucosa* sp. nov.; claw.
46. *Dicyrtomina verrucosa* sp. nov.; claw, frontal aspect.
47. *Dicyrtomina verrucosa* sp. nov.; mucro.
48. *Dicyrtomina verrucosa* sp. nov.; spines from hind abdomen.

TEXT FIGURE

FIG. 1. Relation of length of abdomen to size of body.

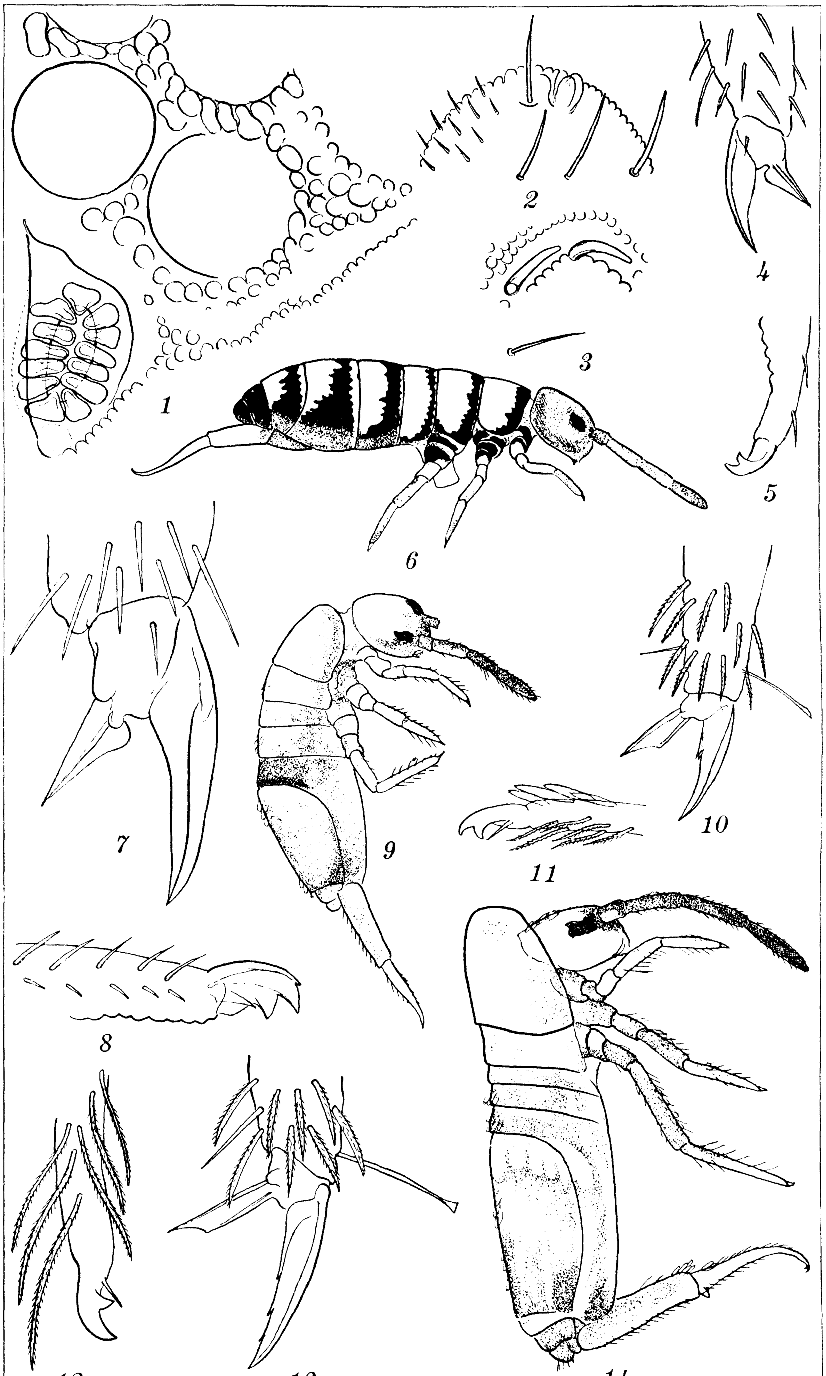

PLATE 1.

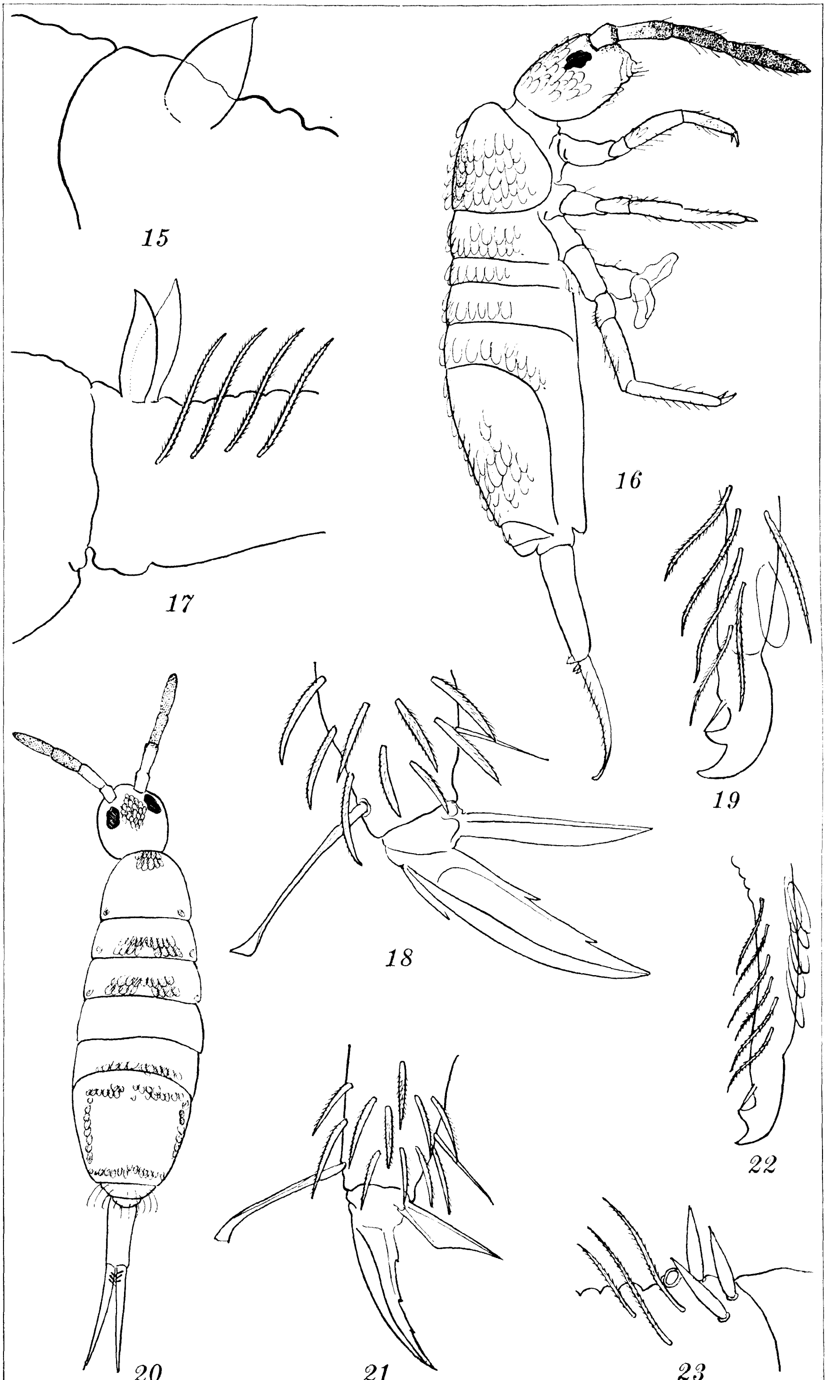

PLATE 2.

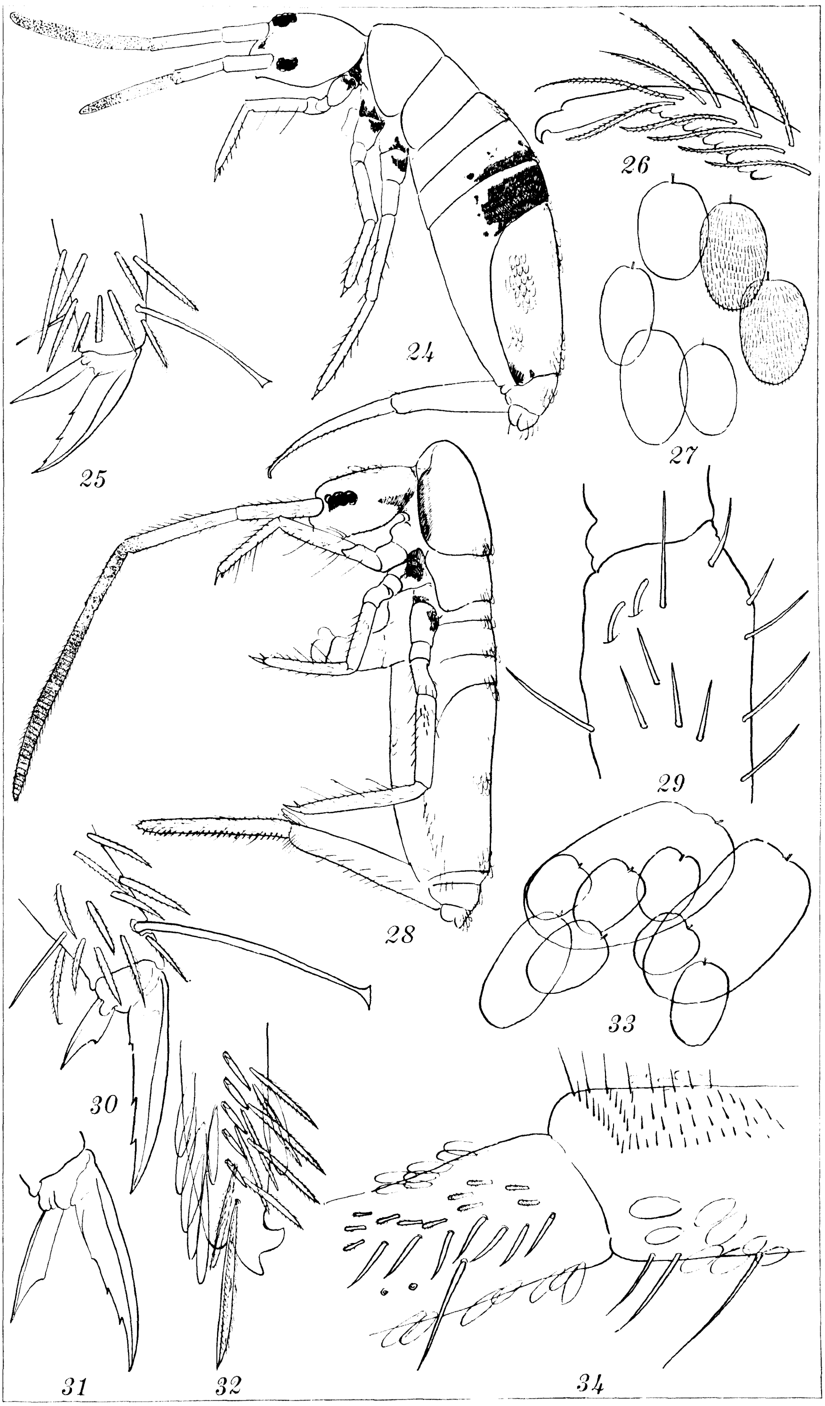

PLATE 3.

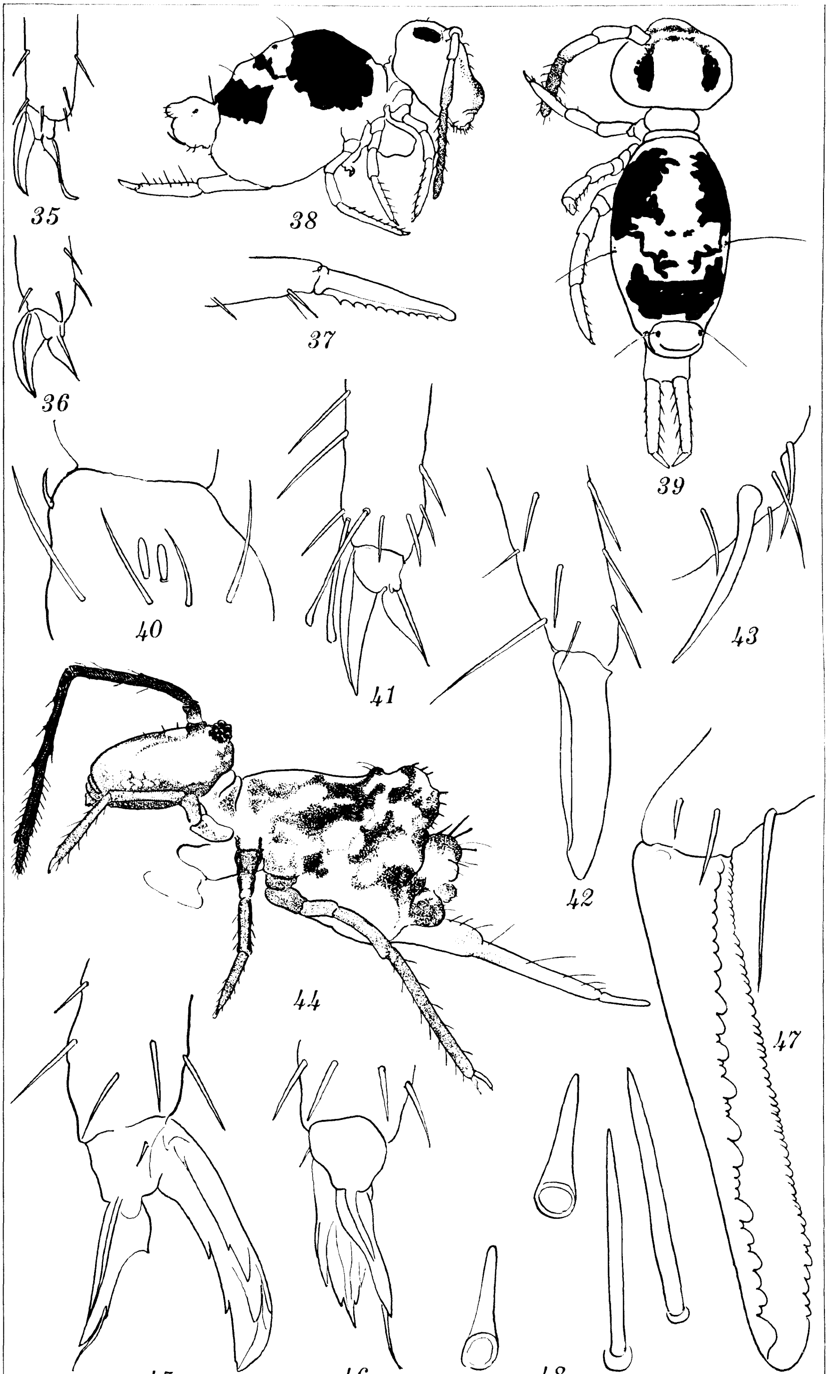

PLATE 4.

FERNS OF MONGOLIA, CHINESE TURKESTAN, AND WESTERN MANCHURIA

By Boris Fedtschenko

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An interest in the problem of classification of the ferns of the vast territory limited by Siberia and Turkestan—namely, Mongolia, Chinese Turkestan, and Western Manchuria (not included in V. L. Komarof's Flora of Manchuria)— was suggested to me by a systematic arrangement of data concerning the distribution of ferns within the boundaries of both the European and the Asiatic parts of Soviet Russia on which I had been working. An answer to the question appeared certainly indispensable for a proper appreciation of the ferns of the Russian flora. Unfortunately, however, the only list of Mongolian vascular plants compiled by C. I. Maximovicz [1] as early as 1859, gives no clue to the answer, as not one of the 450 species of his list is a fern. Neither are ferns mentioned in the later literature on the Mongolian flora, or they are discussed in relation to separate small districts only. Herbaria had to be resorted to in consequence, and numerous specimens were found; some of them classified by eminent authorities, such as C. I. Maximovicz, V. L. Komarof, K. K. Kossinsky, Adr. Franchet, J. Milde, A. Fomin, and others, some left without any nomenclature whatever; to the latter belongs the excellent collection of P. S. Mikhno, kindly offered me for systematization, and all the very curious material of H. Krascheninnikof (1925) and E. P. Gorbunova (1924). Having supplied the data of the herbaria with annotations and having likewise inserted N. V. Pavlof's indications on his brilliant collections in Central Mongolia (1924), we offer in the present paper a list of ferns of the said territory. The localities determined by me from herbaria data have been indicated with an exclamation point (!) following the surname of the collector. The localities have been grouped on a plan of more or less

[1] Index florae Mongoliae; see Maximovicz, Primitiae florae Amurensis in Mémoires prés. à l'Acad. des Sciences de St. Pétersbourg par divers savants 9 (1859) 479-486.

natural regions. The orographical conditions of the country have been taken as most expressly telling on the contents of the flora of ferns and testifying as to its relationship to the adjacent flora. Such are the following regions: [2]

1. The Eastern Altai.
2. Urianhai-Sayan.
3. Urga-Onon (Kentei Mountains).
4. Khangai.
5. The Great Khingan.
6. Alashan.
7. Gobi Altai.
8. The Eastern Tian Shan.
9. Tian Shan and Dzungarian Alatau.
10. The Dzungarian Plain.

They are supposed to comprehend those localities only where one kind of fern at the least was observed, some of them being separated by wastes devoid of ferns. To give an opinion on the botanical and geographical division of the whole of Mongolia (and Chinese Turkestan) with more precision will prove possible only after an analysis of the distribution of different plant groups has been made—both of those to be met throughout all the country and those characterizing some definite regions.

Regarding the distribution of Mongolian ferns the following conclusions can be inferred:

1. The number of representative ferns (Polypodiaceæ, Ophioglossaceæ, Salviniaceæ, Marsileaceæ) is thirty-five plus two erroneously indicated in Mongolia. The number is considerable if compared with the adjacent Turkestan and the Kirghiz region where thirty-four species only are known.

2. An augmentation of the number can certainly be expected from subdivision of the larger species; the discovery on the Tian Shan and the Altai of species heretofore unknown is also possible, but it is certain to be of small significance.

3. Endemic species are none.

4. A considerable number of species belongs to the Eurasians whose distribution has been very extensive. Fourteen species are to be found both in Siberia and in Turkestan; fourteen others in Siberia, but not in Turkestan; and seven more in Turkestan, but not in Siberia.

5. The richest region is that of the Sayan Urianhai, with twenty-one species, where the Siberian types are represented best.

[2] The spelling of geographical names is either supported by Keith Jonston's Royal Atlas of Modern Geography (1861) and the geographical gazeteer of Webster's New International Dictionary (1924) or else combined on their principles.

6. The second place in this respect is occupied by the Tian Shan and the Dzungarian Alatau, thirteen species, where the Turkestan type prevails.

7. The Chinese type is represented by two species; namely, *Asplenium sarelli* in Alashan (this species, however, reaches the Russian Altai in the northwest), and *Cyclophorus assimilis* in Great Khingan.

8. Traces of a Mediterranean element (*Ceterach officinarum*) do not extend farther than the Kuldja and the Tian Shan.

9. The fern flora of Alashan is very poor (two species) and the Eastern Tian Shan and the Gobi Altai have yielded but one species, each partly owing to unfavorable climate and partly to a lack of information concerning these regions.

10. The deserts of the Chinese Dzungaria have only a few representatives (three species), chiefly among water ferns (*Salvinia, Marsilea*).

11. The Inner Desert of Gobi is quite devoid of ferns, as much as the plain of Chinese Turkestan.

Genus WOODSIA R. Brown

WOODSIA GLABELLA R. Br.

Woodsia glabella R. BR. ap. Richards., Frankl. Narr. of a Journ. (1823) 754.

Woodsia asplenioides RUPR., Distrib. Cryptog. Ross. (1845) 55.

2. Koso-gol Lake, 6 and 7–VII–02 (*Komarof!*). Araz, near Koso-gol, 15–VII–02; and Dolboi in the vicinity of Koso-gol, 26–VI–01 (*Komarof!*). Tannu Ola, Baikhaka district, 20–VII–15 (*Miklashevskaia!*). *Woodsia asplenioides,* described by Ruprecht, is referred to by him for the "Mongolia chinensis" and "Dahuria vicina." The authentic specimen is evidently connected with *W. glabella* R. Br., and not with *W. alpina* (Bolton) Gray as suggested by Christensen (Ind. Filic.).

WOODSIA ILVENSIS (Linn.) R. Br.

Woodsia ilvensis (Linn.) R. BR., Prodr. (1810) 158; Trans. Linn. Soc. London 11 (1815) 17.

Acrostichum ilvense LINN., Sp. Pl. ed. 1 (1753) 1071.

Mentioned: PALIBIN, Mater. Mongol. Flor. I No. 3; SHISHKIN, Urianhai 123; PRINTZ, Veg. Sib. Mong. Front. 102.

1. Aksu, Dzandlyk (*Saposhnikof!*).

2. In the vicinity of Koso-gol Lake, 1902 (*Komarof!*). Munku Sardyk (1897) No. 24 (*Peretolchin!*). Urianhai, Valley of the Khoroz, 8 versts to the estuary (*Shishkin!*). In the vicinity of Azass, below Chevar-Kul Lake, 9–VIII (*Krilof!*).

Lower and Upper Azass (*Krilof!*). The Tannu Ola Range, upper course of the Kuile (*Krilof!*). The Tannu Ola, Khandakaila Pass, 28 to 30–VI–15 (*Tugarinof!*). Tannu Ola, Baikara district, 20–VII–15 (*Miklachevskaia!*). The Sisti-kem (*Printz!*).

3. Urga: 12 versts east to Urga, 16–VI–97, No. 35 (*Klementz!*). Ulentui River, 42 kilometers south of Troitzkosavsk, 21–VII–13 (*Mikhno!*). The Noin Ula settlement, 26–V–24, No. 204 (*N. Pavlof!*). The Shildgerein peet bog, 12–VII–97 (*Klementz!*). Along the middle course of the Bakulei (*Molesson!*).

4. On Dschargalanta River, 14–VIII–25 (*Krascheninnikof and Samatkinof!*), Nos. 561/48, 875/159,709, and 978/170, var. *acuminata* Fomin. Near Orotschen-sume, on granite rocks, 23–VIII–25 (*Krascheninnikof and Samatkinof!*). Between Urga and Lake Ische-tuchum-nor, Mount Ulan-bischiktychoda, 9–VIII–25 (*Krascheninnikof and Samatkinof!*) var. *acuminata* Fomin. In the vicinity of Lake Ische-tuchum-nor, Tamanyama Gorge, VII–1926 (*Samatkinof!*). In the vicinity of Ische-tuchum-nor Lake, Mount Bayn-surche, 25–VII–26; Mount Ulandamger, VII–1926; Mount Mongol, VII–1926; Mount Dulga, VII–1926 (*Samatkinof!*) f. *acuminata* (Fomin). Tzakh Mountains, in the Valley of the Sudj, 9–VII–24, No. 153 (*N. Pavlof!*). Along Orkhon River, 1891, No. 162 (*Levin!*). Valley of the Ikhi-gatzar-agol, 22–VI, and the Valley of Dzirgamantu, 23–VII–1894 (*Kashkarof!*). Bombot Mountain near Saingagan, 25–VII–26 (*N. Pavlof!*) var. *rufidula* (Michx.) Aschrs.

9. Borotala (*Schrenk!*).

WOODSIA SUBCORDATA Turcz.

Woodsia subcordata TURCZ. in Bull. Soc. Natur. Moscou 5 (1832) 206.
Mentioned: RUPR., Distr. Cryptog. Ross. 52; POTANIN, Bot. Khingan 442 (*W. hyperborea*).

3. Northwest to the Dahban-urto station (*Ladygensky!*).

5. The Eastern declivity of the Khingan, Talvar River, 20–VII–99 (*Potanin and Soldatof!*). The Mergen district from Tunkhen to Ai-uno (*Ladigin!*).

Genus CYSTOPTERIS Bernhardi

CYSTOPTERIS FRAGILIS (Linn.) Bernh.

Cystopteris fragilis (Linn.) BERNH. in Schard. neu. Journ. 1 (1806) 26, *t. 2, f. 9.*
Polypodium filix fragile LINN., Sp. Pl. ed. 1 (1753) 1091.
Mentioned: SHISHKIN, Urianhai 123; FEDTSCH., Consp. Turk. Kirg. No. 2; PRINTZ, Veget. Siber. Mong. Frontr. 102.

1. The Eastern Altai, Kerkuru, 8–VII–77 (*Potanin!*). Yamati River (Upper Selenga), 1–IX–77 (*Potanin!*). The northern declivity of Ulandaban, in a forest of *Larix*, 22–VI–79 (*Potanin!*). Kandagatta, 14–IX–76 (*Potanin!*). The Mongolian Altai: Onkatu, 25–VI–02 (*Saposhnikof!*); Kaurti, Chingesjay (*Krilof!*).

2. Northern foot of the mountains of the Tannu Ola Range, Turgailyk River, 24–VII–11. (*Miklashevskaia!*). Koso-gol Arassae Valley, 15–VII–02 (*Komarof!*). The mountains at the foot of Munku Sardyk, 21–VII–02 (*Komarof!*); Valley of the Ulei, 18–VII–02 (*Komarof!*). The eastern shore of the Koso-gol, the estuary of Khabsyl River, 10–VII–98, No. 1 (*Peretolchin!*). Koso-gol, Khilin, 2–VII–02 (*Komarof!*). Urianhai, along the Khoroz and Chingeskhem, the Ulu-o tributary, Karakul Lake (*Shishkin!*). The lower country of the Azass from estuary to lakelets, 5–VIII–92 (*Krilof!*). Urianhai, Upper Sisti-kem (*Printz!*). Valley of the Kharkir, 21–VIII–79 (*Potanin!*).

3. Ulentui River, 21–VII–23 (*Mikhno!*). In the Khuanto peet bog, foliferous wood, 9–VIII–97, No. 65 (*Klementz!*). Mountains south to Urga, wooded hillside of the Bogusul, 5–VII–99 (*Palibin!*). Between Troitskosavsk and Urga, 30–VIII–23, No. 150 (*N. Pavlof!*).

4. Valley of the Ishükit, below Dodnor Lake (in Darkhat language called "Khadinai ulun"), a decoction used against toothache, 5–VI–80 (new style) (*Potanin!*). Kangate, 18–IX–76 (*Potanin!*). On Dschargalanta River, 5–IX–1925 (*Krascheninnikof and Samatkinof!*). In the Taskh Mountains along Suchor River, 10–VII–24, No. 149 (*N. Pavlof!*) var. *anthriscifolia* Koch. Halsandaba near Sain-gagan, 3–VIII–26 (*N. Pavlof!*) var. *dentata* Hook.

7. The center of Mongolia, Doundu Saikan Mountains, 7–VII–09 (*O. Chetirkin!*).

8. Between Khami and Uliasutai, the northern declivity of the Narat, the upper woody zone of Tsanlue Valley, 6,000 to 7,000 feet, 5 to 10–VI–77 (*Potanin!*).

9. The Dzungarian Alatau: Sairam, Borgati Springs, 500 feet, the upper Taldi, 900 to 1,000 feet, Arislin; Bogdo Mountain, 6,000 to 7,000 feet, Pilutschi Spring, 7,000 to 8,000 feet (*A. Regel!*). Kash Valley, 9,000 feet (*A. Regel!*). Sairam, 8,000 to 9,000 feet (*Fetissof!*). Tian Shan: Burkhan-tau (*Fetissof!*); Dzagastai, 4,000 to 7,000 feet, Musart 5,000 to 7,000 feet (*A. Regel!*).

10. The steppe valley of the Black Irtish, Kichkinatau, 16 to 28–VII–76 (*Potanin!*).

CYSTOPTERIS MONTANA (Lam.) Bernh.

Cystopteris montana (Lam.) BERNH., Desv. Prodr. (1827) 264.
Polypodium montanum LAM., Fl. Franc. 1 (1778) 23.
Mentioned: SHISHKIN, Urianhai 123; PRINTZ, Veg. Sib. Mong. Front. 103.

2. The woody Urianhai, in subalpine districts of Kara-kul Lake, 18–VII–09 (*Shishkin!*). Tannu Ola, in the Baikhana district, 21–VII–15 (*Miklashevskaia!*). Urianhai, in the Altaian, in subalpine coniferous woodlands (*Printz!*).

Genus STRUTHIOPTERIS Willdenow

STRUTHIOPTERIS GERMANICA Willd.

Struthiopteris germanica WILLD., Enum. (1809) 1071, Mag. d. Ges. f. Naturf. Fr. z. Berlin (1809) 160.
Osmunda struthiopteris LINN., Sp. Pl. ed. 2 (1753) 1066.
Mentioned: PRINTZ, Veg. Sib. Mong. Front. 103.

2. Urianhai, common in woods along the Sisti-kem and the Bei-kem (*Printz!*).

3. The Ulentui, 40 kilometers south to Troitskosavsk, 21–VII–23 (*Mikhno!*).

4. The Muniola Mountains, in birch woods, 26–VI–71 (*Przevalsky!*). This is probably the plant referred to by V. Komarof (Botanical itineraries of the main expeditions to Central Asia, p. 20) under the name of *Athyrium filix femina* Roth.

Genus DRYOPTERIS Adanson

DRYOPTERIS DILATATA Gray.

Dryopteris dilatata GRAY, Man. ed. 1 (1848) 631.
Mentioned: PRINTZ, Veg. Sib. Mong. Front. 103 (*Aspidium spinulosum* subsp. *dilatatum*).

1. Urianhai, Upper Sisti-kem, on the upper limit of the forest region (*Printz!*).

DRYOPTERIS FILIX MAX (Linn.) Schött.

Dryopteris filix max (Linn.) SCHÖTT, Gen. Fil. ad. (1834) *t. 9*.
Polypodium filix max LINN., Sp. Pl. ed. 2 (1753) 1090.
Mentioned: FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 5.

1. The Dzungarian Alatau: along Kasch River, Borgati Spring, 1,600 to 2,000 meters; Borborogoossun, 2,700 meters; Ulustai Gorge, between Talkin and Aksu Valleys; Kungehz (*A. Regel!*). On Sarytzogan River (*Larionof!*). Tian Shan: the

Akburtash and Sharahboguchi Mountains, 1,300 to 1,600 meters; near Khanakai River, 1,600 to 2,000 meters.

DRYOPTERIS FRAGRANS (Linn.) Schött.

Dryopteris fragrans (Linn.) SCHÖTT, Gen. Fil. ad. (1834) *t. 9.*
Polypodium fragrans LINN., Sp. Pl. ed. 2 (1753) 1089.

1. Aksu River (the White Kobdo), 22–VII–09 (*Saposhnikof!*).

2. Urianhai, the estuary of the Taxa, rock, 24–VIII–16 (*Miklashevskaia!*). Urianhai, northern limit of the Tannu Ola along Urgailyk River, Baikhal River, 24–VII–16 (*Miklashevskaia!*). Urianhai, the Tannu Ola Range, above Akkarasook (*Krilof!*). The Sayans, Bujba River, 10–VI–16 (*Miklashevskaia*).

3. Khangai, Tamir River, coniferous forest, 25–IX–86 (*Potanin!*). Bomin Mountain, near Sain-gagan, 26–VII–24 (*N. Pavlof!*). On Bombot Mountain, near Sain-gagan, 25–VII–26 (*N. Pavlof!*).

4. The Mergen district, Erkeshan Volcano and others, 13–VI to 13–VII–10 (*Ladygin!*).

Besides which there is a specimen bearing the insufficient label "S. W. Mongolia, mountains (*Moellendorff!*)."

DRYOPTERIS LINNAEANA C. Chr.

Dryopteris linnaeana C. CHR., Ind. Filic. (1905) 275.
Dryopteris pulchella HAYEK, Fl. v. Steierm. (1908) 39.
Polypodium pulchellum SALISB., Prod. (1796) 403.
Polypodium dryopteris LINN., Sp. Pl. ed. 2 (1753) 1093.
Mentioned: SHISHKIN, Urianhai 124; KRILOF, Fl. Alt. No. 1769.

1. The wooded Urianhai: Chingeokhem River; Khoroz River, in its lower course, Valley of the Karagash near its estuary, 10–VII; declivities stretching towards Kara-kul Lake, 18–VII (*Shishkin!*); slope leading from Dzelamarti Pass to Doro-kul Lake in the neighborhood of Todji-kul Lake; near the upper Azass; in the lower part of Oiva-taiga Mountain (*Krilof!*).

2. Ulentui River, 42 kilometers south of Troitskosavsk, 21–VII–23 (*Mikhno!*).

DRYOPTERIS PHEGOPTERIS (Linn.) C. Chr.

Dryopteris phegopteris (Linn.) C. CHR., Ind. Fil. (1905) 284.
Polypodium phegopteris LINN., Sp. Pl. ed. 2 (1753) 1089.
Mentioned: PRINTZ, Veg. Sib. Mong. Front. 104 (*Phegopteris polypedioides* Fée).

2. Urianhai, in coniferous forests, on the upper Bei-kem near Mosgalewsky (*Printz!*).

DRYOPTERIS ROBERTIANA (Hoffm.) C. Chr.

Dryopteris robertiana (Hoffm.) C. CHR., Ind. Fil. 289 (1905).
Polypodium robertianum HOFFM., Deutschl. Fl. 2 (1795) 20.
Mentioned: SHISHKIN, Urianhai 124.

2. Northern Tannu Ola, foot of mountains along Tailyk River, 24–VII–16 (*Miklashevskaia!*). The wooded Urianhai, along the Chingeoekhem, tributary to the Ulu-o (*Shishkin!*).

3. The Dzun-modo gold mines, on Urtodaban Mountain, 7–VII–23, No. 230 (*A. Gnadberg!*). The Dzun-modo gold fields, 6–VIII–22, No. 512 (*V. Lissovsky!*).

DRYOPTERIS SPINULOSA (Müll.) O. Kuntze.

Dryopteris spinulosa (Müll.) O. KUNTZE, Rev. Gen. Pl. 2 (1891) 813.
Polypodium spinulosum MÜLL., Fl. Dan (1777) t. 707.
Mentioned: SHISHKIN, Urianhai 124; PRINTZ, Veg. Sib. Mong. Front. 103.

2. The woodland Urianhai, upper Azass, 11–VIII (*Krilof!*). On the Sisti-kem, in forest (*Printz!*).

There is in the herbarium of the Principal Botanical Garden another specimen bearing the insufficient label, "The mountains of Southern Mongolia, *N 890 Moellendorff!*."

DRYOPTERIS THELYPTERIS (Linn.) A. Gray.

Dryopteris thelypteris (Linn.) A. GRAY, Man. ed. 1 (1848) 630.
Acrostichum thelypteris LINN., Sp. Pl. ed. 2 (1753) 1071.
Mentioned: FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 4.

1. The Dzungarian Alatau: Kasch, the Borgati Spring, 1,000 meters (*A. Regel!*), along the Tabildlja, 1,300 meters (*Larionof!*).

Genus POLYSTICHUM Roth

POLYSTICHUM LONCHITIS (Linn.) Roth.

Polystichum lonchitis (Linn.) ROTH, Fl. Germ. 3 (1800) 71.
Polypodium lonchitis LINN., Sp. Pl. ed. 2 (1753) 1088.
Mentioned: FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 10.

9. The Dzungarian Alatau, on Arislin River, in the Valley of the Kasch, 2,600 meters (*A. Regel!*).

Genus ATHYRIUM Roth

ATHYRIUM ALPESTRE (Hoppe) Rylands.

Athyrium alpestre (Hoppe) Rylands in MOORE, Ferns Gr. Brit. Nat. Pr. 1 (1857) t. 7.
Aspidium alpestre HOPPE, Neu Bot. Taschenb. (1805) 216.
Mentioned: PRINTZ, Veg. Sib. Mong. Front. 104.

2. Urianhai, rather common in the Altaian, in somewhat moist places, above the limit of trees, at an altitude of from 1,800 to 2,000 meters (*Printz!*).

ATHYRIUM CRENATUM (Sommerf.) Rupr.

Athyrium crenatum (Sommerf.) Rupr., NYLAND, Spicil. Pl. Fenn. 2 (1844) 14.

Aspidium crenatum SOMMERF., Vet. Ak. Handl. 1834 (1835) 104.

Mentioned: SHISHKIN, Urianhai 125;. PALIBIN, Mater. II 6; PRINTZ, Veg. Sib. Mong. Front. 105.

2. Tannuola, northern foot of mountains, Urgailik, Baikhaka district, 24–VI–16 (*Miklashevskaia!*). Urianhai woodland, hillside from the Dzelamart to the plain of Doro-kul Lake (*Shishkin!*). In the lower part of the Oiva, Mount Taiga, 16–VIII (*Shishkin!*). On stony ground in pine woods on the Upper Sisti-kem along the Kamsara and in the Dora Steppe (*Printz!*).

3. Upper Ero (*Mikhno!*). The Ulentui, 50 kilometers south to Troitskosavsk, 27–VII–23 (*Mikhno!*).

ATHYRIUM FILIX FEMINA (Linn.) Roth.

Athyrium filix femina (Linn.) ROTH, Fl. Germ. 3 (1800) 65.

Polypodium filix femina LINN., Sp. Pl. ed. 2 (1753) 1090.

Mentioned: SHISHKIN, Urianhai 124; PALIBIN, Mater. I No. 2; III 6; SAPOSHNIKOF, Mong. Alt. (*Asplenium filix femina* Bernh.); PRINTZ, Veg. Sib. Mong. Front. 104.

1. The Mongolian Altai, Chekhan, woodland (*Saposhnikof!*).

2. The right bank of the Ero, in the Khodotia locality, 30–VI (*N. Titoval!*). Urianhai, in the Valley of the Sisti-kem (*Shishkin!*). The Algiak Pass, the Alglat estuary, the upper Sisti-kem along the Kahmsara, and near the Utin cataracts, up to 1,800 meters above sea level (*Printz!*).

3. Valley of the Ukhtal, tributary to the Ere, 12–IX–23, No. 534 (*A. Gnadberg!*) var. *multidentata.* The Dsun-modo gold fields, 8–VIII, No. 1023 (*V. Lissovsky!*) var. *multidentata.* The middle course of the Bakulei, 1899 (*Molesson!*).

4. The estuary of the Ero (*Mikhno!*). The Ulentui, 1921 (*Mikhno!*).

5. Mongolia, the Valley of the Dzirgalantu, 22–VI–94 (*Kashkarof!*).

The Muniola Mountains have also been indicated (Przevalsky), supported by Komarof (Botanical itineraries of the main expeditions into Central Asia, p. 20), but the indication probably refers to *Struthiopteris germanica* Willd., as the only fern of the locality contained in the Przevalsky herbarium belongs to that species.

ATHYRIUM MONGOLICUM (Franchet) Diels.

Athyrium mongolicum (Franchet) DIELS, in Engl. and Prantl, Natürl. Pflanzenfamil. 1[4] (1899) 224.

Asplenium mongolicum FRANCHET, Nouv. Arch. Mus. 7 (1883) 161.

Mentioned by Franchet (loc. cit.) in Eastern Mongolia: Jegol (David); however, the locality belongs to China proper, in Chihli Province, beyond the limits of our investigations.

Milde (Fil. Europ. 54) describes *A. fallaciosum* Milde in Northern China; V. Komarof (Flora of Manchuria I) thinks *A. mongolicum* Franchet is a synonym of that plant.

Genus ASPLENIUM Linnæus

ASPLENIUM PSEUDOFONTANUM Koss.

Asplenium pseudofontanum KOSS., in Not. Syst. ex Herb. Horti Botan. Petrop. 3 (1922) 121.

Mentioned: FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 19 (*A. fontanum*).

9. Dzungarian Alatau; Borgati, 1,650 meters from Borgati to Kapchagai on the left side of the Kasch, 2,100 to 2,400 meters (*A. Regel!*).

ASPLENIUM RUTA MURARIA Linn.

Asplenium ruta muraria LINN., Sp. Pl. ed. 2 (1753) 1081.

Mentioned: PRINTZ, Veg. Sib. Mong. Front. 105; FEDTSCHENKO, Consp. Fl. Turk. and Kirg.

2. Near Ust-algiac, on the Sisti-kem (*Printz!*).

9. Tian Shan, Tekess River, 16–VI–03 (*Roborovsky!*). Along Moozart River, 1,700 to 2,400 meters (*A. Regel!*). Dzungarian Alatau, near Lake Sairam (*A. Regel!*).

ASPLENIUM SARELLI Hk.

Asplenium sarelli HK. in Blakiston, Yang-tsze (1862) 363–364.

6. Alashan, in abruptiis montium, 25–VI–73 No. 169 (*Przevalsky!*).

ASPLENIUM SEPTENTRIONALE (Linn.) Hoffm.

Asplenium septentrionale (Linn.) HOFFM., Deutschl. Fl. 2 (1795) 12.

Acrostichum septentrionale LINN., Sp. Pl. ed. 2 (1753) 1068.

Mentioned: PRINTZ, Veg. Sib. Mong. Front. 105; FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 14.

2. On dry hillsides facing south in Ust-algiac, rather common (*Printz!*).

9. The Dzungarian Alatau, Talki (*A. Regel!*); Borokhudzir near Karagali *Fetissof!*). Tian Shan, Moozart, 1,800 to 2,000 meters; Sharabagutshi, 1,300 to 1,700 meters (*A. Regel!*).

ASPLENIUM TRICHOMANES Linn.

Asplenium trichomanes LINN., Sp. Pl. ed. 2 (1753) 1080.
Mentioned: FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 15.

9. Tian Shan, Urtass-aksu (*Fetissof!*). Kungess, near Moozart River, 2,300 meters. Khanakhai in the Akburtash Mountains, 1,700 to 2,400 meters (*A. Regel!*).

ASPLENIUM VIRIDE Huds.

Asplenium viride HUDS., Fl. Angl. (1762) 385.
Mentioned: PRINTZ, Veg. Sib. Mong. Front. 105.

2. In moist subalpine coniferous forests and the Upper Sistikem (*Printz!*).

Genus CETERACH Lamarck

CETERACH OFFICINARUM DC.

Ceterach officinarum DC., Fl. Franc. 2 (1805) 566.
Asplenium ceterach LINN., Sp. Pl. ed. 2 (1753) 1080.
Mentioned: FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 20.

9. Tian Shan, Sharabagoutchi, 1,300 to 1,700 feet, in the Akburtash Mountains, Moozart River (*A. Regel!*).

Genus CHEILANTHES Swartz

CHEILANTHES ARGENTEA (Gmel.) Kze.

Cheilanthes argentea (Gmel.) KZE. in Linnaea 23 (1850) 242.
Pteris argentea GMEL., Nov. Comm. Petrop. 12 (1768) 519, *t. 12, f. 2.*
Mentioned: SHISHKIN 125; POTANIN, Great Khingan 442.

2. Koso-gol Lake, 6–VII–02 (*Komarof!*). Urianhai along Uieck River, near the estuary of the Madsel (*Shishkin!*).

4. Valley of the Tol, near the crossing of the Zainshabin road, 2–VII–24, No. 148 (*N. Pavlof!*). Dschargalanta River, 14–VIII–25 (*Krascheninnikof and Samatkinof!*). Mountains east to the Orkhon, 3–X–86 (*Potanin!*). Hontu-tamir River, 17–VIII–26 (*N. Pavlof!*). Valley of the Urto-tamir, near the Zaingaghen khure, 29–VII–24, No. 147 (*N. Pavlof!*).

Genus CRYPTOGRAMMA R. Brown

CRYPTOGRAMMA STELLERI (Gmel.) Prantl.

Cryptogramma stelleri (Gmel.) PRANTL, in Engl. Bot. Jahrb. 3 (1882) 413.
Pteris stelleri GMEL., Nov. Comm. Petrop. 12 (1788) 519.
Allosorus stelleri RUPR., Distrib. Crypt. Vasc. Ross. (1845) 47.

2. Koso-gol Lake, Arassai Valley, 14–VII–02 (*Komarof!*). The Sayans, the estuary of the Buida, tributary to the Oussah, 10–VI–16 (*Miklashevskaia!*).

Genus PTERIDIUM Gleditsch

PTERIDIUM AQUILINUM (Linn.) Kuhn.

Pteridium aquilinum (Linn.) KUHN, in v. Deck Reisen 3 ' (1879) Bot. 11.

Pteris aquilina LINN., Sp. Pl. ed. 2 (1753) 1075.

Mentioned: PALIBIN, Mater. Fl. Mongol. 1: No. 1; 3: 6; 4: 39; PRINTZ, Veg. Sib. Mong. Front. 105.

2. Between Dzida River and Lake Koso-gol, the estuary of Khalun-arshan (*Molesson!*). Urianhai, common in subalpine coniferous forests. On the Altaian, at Ust-algiac, at Ust-sistikem (*Printz!*).

3. The Dzun-modo gold fields below Ayren-daba, 25–VIII–23, No. 23 (*A. Gnadberg!*). Khalkha, the Valley of Ero River, and the tributaries Ukhtai and Boroi, 6 to 8–VII–06, 800 to 1,200 meters (*Novitzki!*). The middle course of the Bakulei, 1899 (*Molesson!*). Ulentui River, 21–VII–23 (*Mikhno!*). The estuary of Ero River (*Mikhno!*).

5. The Khingan, 8–VII–07 (*Lipsky!*).

Genus POLYPODIUM Linnæus

POLYPODIUM LINEARE Thunb.

Polypodium lineare THUMB., Fl. Japon. (1784) 335.

Polypodium alberti RGL. in Act. Hort. Petr. 7 (1881) 662.

Mentioned: FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 26.

9. The Dzungarian Alatau, Irenkhabirga Zaganssu, 2,000 to 2,600 meters (*A. Regel!*). Tian Shan, near the Mouzart Pass, 2,000 to 2,600 meters (*A. Regel! Fetissof!*).

POLYPODIUM VULGARE Linn.

Polypodium vulgare LINN., Sp. Pl. ed. 2 (1753) 1085.

Mentioned: PRINTZ, Veg. Sib. Mong. Front. 176; FEDTSCHENKO, Consp. Fl. Turk. and Kirg. No. 25.

2. Urianhai, northern foot of mountains of the Tannu-ola, near Urgalaik River, 24–VII–16 (*Miklashevskaia!*). Urianhai, along Azass River, near Lake Chevarkul (*Shishkin!*). Tannu Ola, Upper Kuile (*Krilof!*). Along the Kamsara (*Printz!*).

3. In chinks of rocks along the northern declivity in the Dzakh Mountains, in the Valley of the Suchj, 10–VII–24, No. 152 (*N. Pavlof!*) var. *rotundatum* Milde. The Ulentui, 40 versts to Troitskosavks, 21–VII–23 (*Mikhno*!).

5. Mergensai, the district of the Erkeshan Volcano and others, III to IV–1910 (*Ladygin!*).

9. The Bogdoöla Range, in the great peet bogs, 8–VI–97 (*E. Klementz!*). Dzung-alatau, the Upper Taldi (*A. Regel*); Dzambi, (*Larionof!*). Tian Shan, near Moozart (*A. Regel!*).

Genus CYCLOPHORUS Desvaux

CYCLOPHORUS ASSIMILIS (Baker) C. Chr.

Cyclophorus assimilis (Baker) C. CHR., Ind. Fil. (1905) 198.
Mentioned: POTANIN, Great Khingan 422 (*Polypodium assimile* Baker).

5. Great Khingan, Talir River, on rocks, shady side, 20–VII–89 (*Potanin and Soldatof!*).

Genus SALVINIA (Micheli) Adanson

SALVINIA NATANS (Linn.) All.

Salvinia natans (Linn.) ALL., Fl. Pedem. 2 (1785) 289.
Marsilea natans LINN., Sp. Pl. ed. 2 (1753) 1099.

10. Karairtish, near the Durbaldy crossing, 16 to 28–VIII–76 (*Potanin!*).

Genus MARSILEA Linnæus

MARSILEA STRIGOSA Willd.

Marsilea strigosa WILLD., Sp. Pl. 5 (1810) 539.

10. Karairtish, near the Durbaldy crossing, 16 to 26–VIII–76 (*Potanin!*).

Genus BOTRYCHIUM Swartz

BOTRYCHIUM LUNARIA (Linn.) Sw.

Botrychium lunaria (LINN.) SW. in Schrad. Journ. 1800[2] (1801) 110.
Osmunda lunaria Linn., Sp. Pl. ed. 2 (1753) 1065.
Mentioned: SHISHKIN, Urianhai 125; FEDTSCHENKO Consp. Fl. Turk. and Kirg. No. 32.

2. Koso-gol Lake, Khilin, 2–VII–02. Norin-gol Valley, 24–VI–02; Khors Valley, 28–VII–02 (*Komarof!*). Urianhai woodland, the Valley of the Azass in the vicinity of Chevarkul in the Otig Range (*Krilof!*).

3. Ulentui River, 21–VII–23 (*Mikhno!*).

4. The meadows on the mountain pass Halsan-daba, near Sain-gagan, 7–VIII–26 (*N. Pavlof!*).

9. The Dzungarian Alatau, the estuary of the Khorgoss, 9,000 feet, near Lake Sairam, 8,000 feet (*A. Regel!*). Tian Shan, Muzart (*A. Regel!*).

BOTRYCHIUM MATRICARIAE (Schrank) Sprgl.

Botrychium matricariae (Schrank) SPRGL., Syst. Veg. 4 (1827) 23.
Osmunda matricariae SCHRANK, Baier. Fl. 2 (1789) 419.
Mentioned: SHISHKIN, Urianhai 125; PRINTZ, Veg. Sib. Mong. Front. 106.

2. Urianhai, along Sisti-kem River, between the estuary of the Siltiss and Aini, 1–IX–92, No. 957 (*Krilof!*). Ust-algiac and Ust-sisti-kem (*Printz!*).

GEOLOGY AND UNDERGROUND-WATER RESOURCES OF CENTRAL PANAY

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SEVEN PLATES AND TWO TEXT FIGURES

INTRODUCTION

An investigation of the artesian-water resources of any region necessarily entails the study of the geology, with emphasis on the succession of strata and geologic structure. This report will be in effect geologic, but only the phases of geology that are directly related to ground-water circulation will be treated in detail.

The water supply in Iloilo and Capiz has been a problem to the authorities for a long time. A water system with a filtration device for southern Iloilo Province has been completed. The waters of Tigum River at Maasin have been impounded and piped about 26 kilometers to Iloilo. Eleven towns south of the dam will be supplied with potable water.

Artesian wells have been bored in Iloilo and the neighboring towns. Some of the wells flowed and still flow, and others had to be pumped, but the water from nearly all the wells was either brackish or salty and contained much free ammonia gas. Some residents became used to drinking brackish water, but the majority still depend on rain. Except for the eleven towns that will be benefited by the Iloilo waterworks, the water-supply problem is unsolved for Iloilo and Capiz Provinces. In the vicinity of the town of Capiz investigations are being conducted for the construction of a water system similar to that of Iloilo and this will undoubtedly benefit a few towns besides Capiz.

FIELD WORK AND ACKNOWLEDGMENTS

Dr. J. M. Feliciano, head of the Department of Geology and Geography, University of the Philippines, assisted me in the field, and we have attempted to solve the perplexing problems that were encountered. We had two field assistants, Juan Teves

and Escolastico Duterte, both students of geology in the University of the Philippines. We are indebted to the various town officials and friends who accommodated us and saw to our comfort in the field.

AREA INCLUDED IN THIS REPORT

Studies were to be made of the artesian-well possibilities in northern Iloilo Province and in Capiz Province west of the town of Capiz. Work was started in the last week of April and continued until the end of May, when it was stopped on account of the rains. Only the vicinities of the towns of Passi and Calinog in Iloilo Province and of Dumarao and Dumalag in Capiz Province were examined, an area of approximately 600 square kilometers (fig. 1).

PREVIOUS GEOLOGIC WORK

Enrique Abella y Casariego[1] wrote a geologic description of Panay. He started his investigations in 1886, and with the assistance of the cartographer d'Almonte, produced a geologic map of the island. He also made several geologic cross sections.

In 1905 Goodman[2] touched a few places in eastern Panay while collecting data for the Mineral Resources of the Philippine Islands, a publication of the division of mines, Bureau of Science. He did no geologic work.

Reports of the occurrence of petroleum in the vicinity of Janiuay, Iloilo, led to a field investigation in 1912 by Pratt.[3] He found no oil but reported artesian-well possibilities.

Later in the same year, Smith[4] investigated the ground-water resources of the immediate vicinity of the town of Iloilo in an effort to aid in the solution of the water-supply problem there.

In 1922 Elicaño undertook an examination of the guano and rock phosphate deposits in the caves near Dumarao, Capiz. He devoted all his time to caves and accomplished no general geologic work.

PUBLICATIONS ON WATER SUPPLY

Abella y Casariego's[5] work does not primarily deal with water supply; nevertheless, it is the most comprehensive study

[1] Descripción física, geológica y minera de la Isla de Panay. Chofre, Manila (1890).

[2] Smith, W. D., Philip. Journ. Sci. § A 10 (1915) 211.

[3] Smith, W. D., loc. cit.

[4] Loc. cit.

[5] Op. cit., footnote 1.

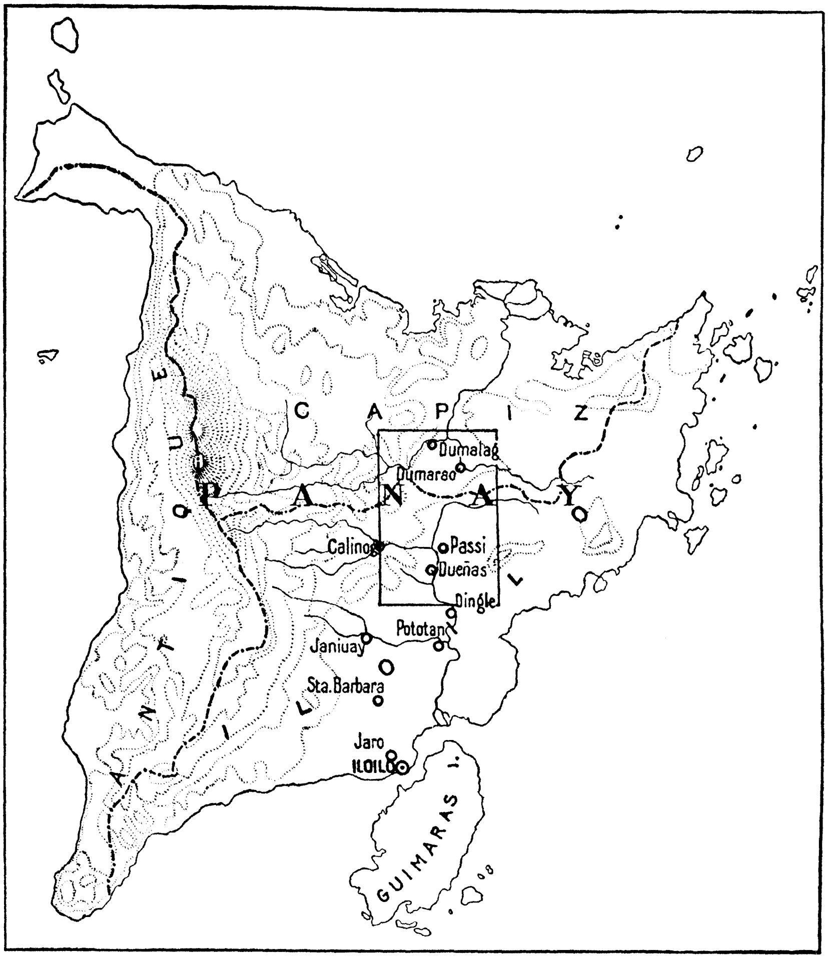


FIG. 1. Panay, showing the area discussed.

of the geology of Panay. The orography, hydrography, altimetry, and the volcanic and sedimentary formations are described in detail. A chapter is devoted to economic geology, but artesian water possibilities are omitted. Structural cross sections across Panay are also included in the work. A general geologic map, referred to above, was produced with d'Almonte's help, but since this work was undertaken on a large scale, detailed studies are necessary to determine the possibilities of artesian wells in each locality.

Barber [6] found that flowing wells show a much higher degree of bacterial purity than pumping wells.

[6] Philip. Journ. Sci. § B 8 (1913) 458.

Vickers[7] describes the drilling of artesian wells in the Philippines and the methods used.

Cox, Heise, and Gana,[8] on page 309 of their article, give the location, number, description, date, physical properties, and reaction of the water from the artesian wells in Iloilo and on page 329, the sanitary analyses. Page 339 explains the high chlorine content of Philippine artesian waters and the high free-ammonia content of those from Iloilo. Quoting from page 339:

According to W. E. Pratt of the Bureau of Science: "The wells at Iloilo are sunk through estuarine deposits which are high in organic matter resulting both from plant and animal remains in the sediments themselves and from included remains of organisms that lived in the salt or brackish water in which the beds were laid down. The character of the water itself is likewise transmitted to the sediments through saturation during deposition and preservation by subsequently deposited overlying strata. Silts with considerable contents of humus, soils, carbonaceous clays, shales and sands impregnated with salts from sea water are the prominent members of the formation. Artesian water is obtained from lenses of sand or fine gravel in the general formation. It is uniformly salty in the lowlying part of the province at a depth greater than approximately 165 meters.

Heise[9] discusses the three water-supply projects that have been proposed for Iloilo; namely, to dig enough artesian wells in the outlying districts to develop a town supply; to throw a dam across Tigum River at Maasin; and to get water from the springs and upland waters of Guimaras Island and to bring it to Iloilo by pipes laid beneath the straits separating Guimaras and Panay. To quote from the conclusions:

The chemical character of the artesian waters is such that their development as a source of municipal water supply does not seem advisable.

The Maasin and the Guimaras Island projects are both feasible, so far as the quality of the water is concerned.

The Maasin project was the one referred to in the introduction and has now been completed.

Heise[10] gives the analyses of waters from deep wells, and some wells in Iloilo are included. The deepest well in the Islands at that time was drilled in the trade-school grounds at

[7] Bull. [Philip.] Bur. of Public Works No. 4, 2 (1914) 24–32.

[8] Philip. Journ. Sci. § A **9** (1914) 273–410.

[9] Philip. Journ. Sci. § A **10** (1915) 65–72. The same author discusses the boiler waters of Iloilo Province, t. c. 74–79.

[10] Philippine Water Supplies, Bureau of Science Publication **11** (1918) 11.

Iloilo to a depth of 2,285 feet without encountering fresh water. The deep-well water of Janiuay, Iloilo, has the highest total solid content (8,200 parts per million) and the highest chlorine content (4,471 parts per million). This well was sunk to a depth of 375 meters, and yields an intensely salt water. The deepest well whose water may be considered potable is 165 meters deep and is located at Santa Barbara. Heise discusses briefly the water supplies of Panay on pages 148 and 149.

Smith [11] discusses the physiography, the general geology, and the ground-water resources of Panay and advocates the drilling of wells in the gravels of the Iloilo plain.

Pratt [12] discusses the water-bearing qualities of Philippine formations. They were classed and summarized in a table in relation to their character as sources of artesian water.

Heise and Behrman [13] treat of Philippine water supplies in all their phases. A reprint of Pratt's paper on artesian wells is included.

PHYSIOGRAPHIC DESCRIPTION OF PANAY

Panay may be divided into three general physiographic provinces; namely, the Western or Main Cordillera, the Eastern Mountain group, and the Central Plain.

There are some moderately high mountains in the western part of Capiz Province, but I have included them in the Main Cordillera with which they are more or less connected.

The Main Cordillera of Panay runs almost north and south, separating Antique Province from Capiz and Iloilo. Besides the mountains of western Capiz and of western Iloilo, which are really foothills of the cordillera, there is a prominent spur from Mount Baloy, the common point of all three provinces, which extends eastwardly almost across the plains to the Eastern Mountains. The two largest rivers of Panay, the Jalaur and the Panay, rise in Mount Baloy and for many kilometers are almost parallel as they flow eastwardly, with the above-mentioned spur separating them. In the low plains the Panay turns northward, and the Jalaur, joined by the Lamunang, southward. In the plains there is only a low wide divide between the basins of the Panay and the Jalaur and the boundary between Iloilo

[11] Philip. Journ. Sci. § A 10 (1915) 211–228.

[12] Philip. Journ. Sci. § A 10 (1915) 231–239.

[13] Philippine Water Supplies, Bureau of Science Publication 11 (1918).

and Capiz Provinces is located on this divide. This low wide divide may be thought of as a continuation of the spur from Mount Baloy.

The Eastern Mountain group is neither a cordillera nor a mountain range, as there is a lack of any regular arrangement of ridges and ranges. It occupies most of the eastern part of Panay east of the Central Plain. The mountains are old volcanic stocks and old worn-down mountains of plutonics and extrusives. The lower hills have accordant levels and were probably made by the erosion of former wide floodplains in both igneous and sedimentary rocks. From Guimaras Strait, looking north at Mount Caniapasan and Mount Bayuso, one notices three horizontal levels, as shown in Plate 2, fig. 3. Therefore, the higher peaks may be thought of as former monadnocks in a peneplain which has been eroded and uplifted three times. Besides the mountains and hills made up of igneous rocks, there are ridges of sedimentary rocks, the limestone, especially, making prominent ridges such as Bayebaye, Camiri, Putian, and others.

The Central Plain is that low-lying broad synclinal area between the two mountain groups. The greater part of it lies in Iloilo Province. It is narrowest along the low wide divide mentioned above, in the vicinity of Dumarao, on account of the Paning Raon Mountain group to the west of it.

The origin of this plain is mainly due to its broad synclinal structure and to the erosion by the two large river systems of Panay. Its lower part, however, is a delta deposited by the Jalaur, on which the town of Iloilo is built. The Panay has also built a small delta.

In the higher portions of this plain, the streams have cut into it several meters, developing lower in their courses wide flood plains, below the higher plains. In reality, therefore, there are two plains; one, lower and very flat, the other higher and with a rolling topography.

PHYSIOGRAPHIC LOCATION OF THE AREA

The area under consideration is situated in the narrowest part of the Central Plain and includes some foothills of the Main Cordillera and part of the Eastern Mountain group. The Paning Raon Mountain group is included in it.

DESCRIPTION OF THE FORMATIONS

TENTATIVE STRATIGRAPHIC COLUMN FOR PANAY

Quaternary. Alluvium up to altitudes of 100 meters; 0 to 30 meters.
Tertiary.
  Pliocene.
    Guadalupe tuff. Tuffs, tuffaceous sandstones, and shales; 100 meters.
    Malumbang limestone (coral reefs); 150 meters.
  Miocene. Lavas and Mount Paning Raon intrusives.
  Oligocene.
    Badbaran formation. Shales, sandstones, limestone intercalations; 700 to 850 meters.
    Binangonan limestone. Limestone, shales, sandstone, limestone; 270 meters.
    Coal Measures. Sandstones, shales, lignite, conglomerates; 300 meters.
  Eocene. None was observed.
Pretertiary. Igneous and metamorphic rocks.

THE COAL MEASURES

The oldest sediments found in the area are the Coal Measures, so-called because of their stratigraphic position and the presence of thin lignite beds in them, which justify their correlation with the coal-bearing formation of the Philippine Islands.

The Coal Measures, in Panay, consist of conglomerate at the very bottom, and above that intercalations of comparatively thin beds of sandstones, shales, and conglomerates, a few thin beds of limestone, and some very thin seams of lignite. A typical section was studied about 2 kilometers from the Government stock farm on the trail to Dumarao. The section follows:

	Meters
Limestone	2
Shales	1
Sandstone	1
Conglomerate (fine)	7
Shales	1.3
Sandstone	0.7
Conglomerate	0.3
Shales	3
Sandstone	0.3
Conglomerate	4

The conglomerates are generally hard and well consolidated. The included pebbles are commonly small and well rounded, and the matrix is a coarse sandstone. Conglomerates are generally

important reservoir rocks, but when their pore spaces have been filled by some cementing material and are well consolidated as are the above-mentioned conglomerates, they cease to be good reservoir rocks.

The sandstones are fine to coarse, close grained, and generally well cemented with limestone. They should carry comparatively little water.

The shales are dark, compact, moderately hard, and well bedded. They are very poor reservoir rocks but make excellent cap rocks.

The few beds of limestone in this formation are hard, compact, and lacking in cavities, probably on account of their thinness. Therefore, they carry very little water.

All in all, the Coal Measures are not good water-bearing rocks, and they should not be depended upon as probable sources of artesian water. Records show that only a few wells drilled in Tertiary sediments have been successful, because they carry little water [13] and they generally retain a great deal of their original salt content.

The thickness of the Coal Measures, estimated from the section along Badbaran River, is about 300 meters. They are in contact with the basal igneous rocks and generally occupy flat rolling lowlands or low rounded hills. As the next higher formation, the Binangonan limestone, is reached, these rolling lowlands and low hills are succeeded by prominent limestone ridges.

THE BINANGONAN LIMESTONE

Except for the few thin beds of limestone in the Coal Measures, the Binangonan limestone is the oldest in the area. It is hard, compact, and seemingly massive. In places it has been metamorphosed to marble. In some localities this limestone is full of joints and cavities, and consequently water percolates with comparative ease. It [14] is considered to be undoubtedly the most important possible source of artesian water among the Tertiary sedimentary rocks, although there are some drawbacks. The limestone may be buried too deep right under the towns, or it may not be so cavernous below the water table. It was observed that springs and underground streams abound in this formation. Among others, Suhut near Dumalag, where an underground

[13] Pratt, W. E., Philip. Journ. Sci. § A 10 (1915) 237.
[14] Pratt, W. E., loc. cit.

stream issues forth, should be mentioned. This has been under consideration as a possible source of water for Dumalag.

The total thickness of the Binangonan limestone is about 270 meters. About the middle of the formation there are present a layer of sandstone and a layer of shales, dividing the formation into a lower and an upper limestone. On account of its superior hardness, the limestone stands out as ridges above the other formations, near the edges of the Central Plain.

THE BADBARAN FORMATION

The name "Badbaran formation" was given to the series of sedimentary rocks conformably overlying the Binangonan limestone because of the excellent exposures along Badbaran River. This series consists of intercalations of thin beds of laminated limestone, shales, and sandstones. The beds are commonly 30 centimeters to 1 meter thick, although, in places, greater thicknesses are attained. The limestones, being hard and destitute of solution cavities and joints, make poor reservoir rocks. There are not many sandstone beds and these are fine-grained and moderately hard, making only fair water-bearing rocks. The shales, being well compacted, should make good cap rocks. On the whole, the Badbaran formation does not offer good prospects as a source of artesian water. Its thickness is estimated to be between 700 and 850 meters. This thickness may not include other beds which do not outcrop in the measured section through Dumarao.

THE MALUMBANG LIMESTONE

Coralline limestone has been encountered in several places making prominent ridges; among them, Bayebaye Mountain, Putian Mountain, Camiri Hills, and others. This limestone is younger than the Badbaran formation and is unconformable on it. It should probably be correlated with the Pliocene Malumbang limestone. It is a coral-reef formation, very porous and full of solution cavities. Many springs issue from this formation, showing that it does not lack water. Since this limestone is generally interbedded with shales or other impervious material, it should be a potential source of artesian water. Unfortunately, this formation does not persist throughout the area; and one cannot foretell its presence or absence under the towns, where the artesian wells are wanted. The thickness is 100 to 150 meters.

THE GUADALUPE TUFF FORMATION

Volcanic tuffs, associated with tuffaceous shales and sandstones and some fossiliferous limestone layers, make up the low hills near the edge of the Central Plain, flanking the higher limestone ridges. There is an excellent exposure of it along the railroad cut between Dumarao and Buntog. It should probably be correlated with the Guadalupe tuff formation of central Luzon, although the latter is very well stratified having been deposited under shallow water, while the Panay tuffs are not so well stratified, and were probably laid terrestrially. It seems that a period of river planation had evened the surface of the tuffs, after which a little elevation and erosion have produced low rolling hills in the tuff with accordant levels about 15 meters above the present flood plains.

Many wells in the tuffs in the Philippines have yielded flows, and a great majority are being pumped. According to Pratt,[15] the bedded tuff formation is, perhaps, more uniformly water bearing than any other of the Philippine rock series. The tuffs are very porous, and being intercalated with shales and sandstones, should make good reservoirs. On the other hand, the tuffs are not evenly distributed throughout the area in question, and in places are probably absent. River planation may have removed them partly or completely in certain areas. For instance, it is doubted very much if the tuffs are present under Passi and Dumarao. They may be present under Dumalag and Calinog. The thickness of this formation probably does not exceed 100 meters.

QUATERNARY ALLUVIUM

The alluvium deposits are, of course, unevenly laid over the area, being thicker along aggrading rivers and in flood plains, especially those that are at some distance from the highlands. The alluvium under Dumarao is probably very thin. In Passi it is thicker, and in Dumalag it is very much thicker. The thickness may not exceed 30 meters, however.

A majority of the wells in the Philippines have been drilled in alluvial deposits, and most of them have been successful. Most of them must be pumped, but a few flow. The deposit should be thick enough so that a well bored in it can be cased to a safe depth and still get the water from it.

[15] Loc. cit.

STRUCTURE AND RECOMMENDATIONS

To insure a circulation of ground water, there should be an inclination of the water-bearing strata. In other words the geologic structure should be a monocline or a syncline. One should never drill for water at or near the crest of an anticline.

The regional structure of the area under consideration is a broad syncline modified by an unsymmetrical or elongated dome pushed up by an igneous intrusion in the mountainous region of Paning Raon. The syncline has been faulted, and it partakes of the nature of a graben. The general structure of the Central Plain of Panay, of which the area in question is a part, is itself a very broad syncline, undoubtedly also faulted. The sedimentary rocks outcrop in the hills and mountains on both sides of the plain, dipping towards the plain. In general, the structure, the topography, and the location of the outcrops are favorable for artesian wells in the Central Plain of Panay.

Four cross sections were made almost due east and west across the area. These will be discussed one by one.

SECTION THROUGH DUMARAO AND MOUNT PANING RAON

Section A–A′ (Plate 1 and fig. 2) was projected in a northwest direction from the section studied in detail along the winding Badbaran River, starting from the point where the Matubang joins it, and ending at Dumarao. Section A′–A″ is a continuation of the section; it starts from Dumarao and runs almost due west through Mount Paning Raon to Panay River. Southeast of Dumarao is a Government stock farm, the greater part of which is situated in a flat included between Maripo Creek and Badbaran River above the mouth of the Matubang. This rolling flat is underlain by basalt, with about 2 meters of alluvium and soil.

Along Badbaran River, about 0.5 kilometer below the mouth of Matubang River, the basal conglomerates of the Coal Measures were first encountered. They are succeeded by shales, sandstones, and a few thin beds of limestone of the same formation. All these sediments have a general westward dip with variable strikes, forming the eastern side of the broad syncline. From the basalt area to the old sedimentaries there is an abrupt change from the rolling flat of the stock farm to the hilly or mountainous zone of the sedimentaries so that Badbaran River here flows through a gorge. The same physiographic feature is present along the whole eastern portion of the area, except

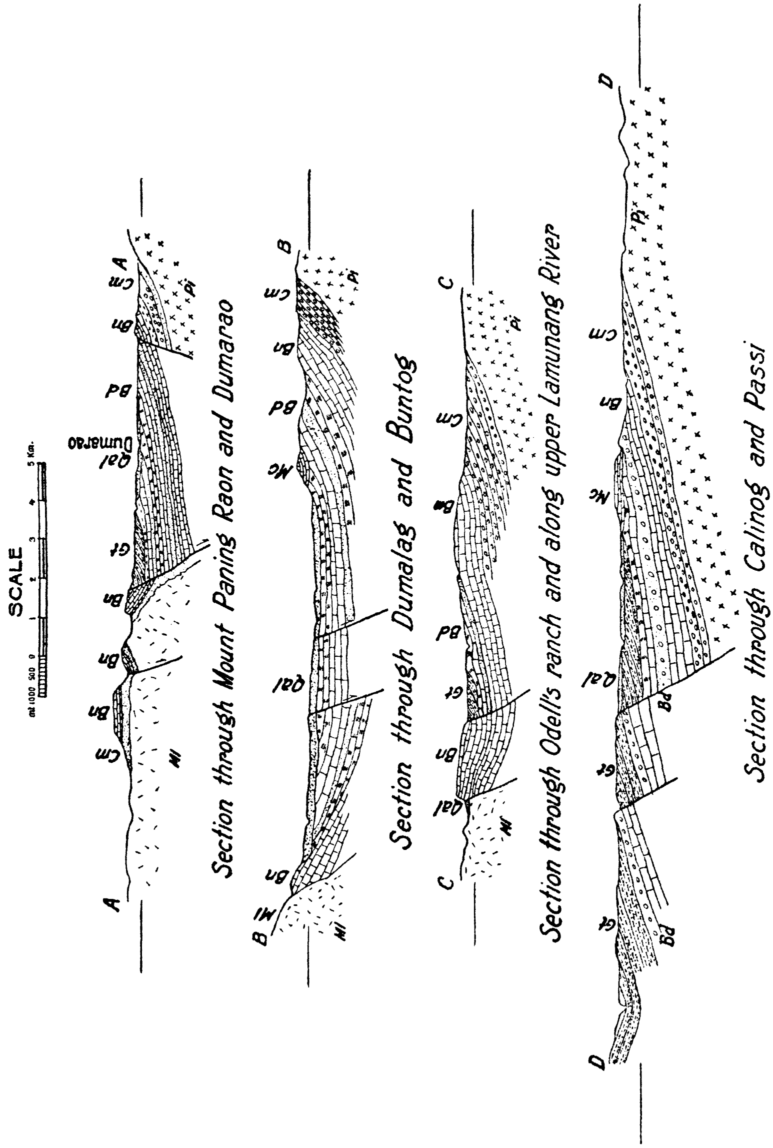


FIG. 2. Geologic cross sections. Refer to Plate 1 for the legend.

that in some cases, as along Lamunang River and Asisig River, the Coal Measures underlie part of the rolling plain east of the zone of hills and ridges of sedimentary rocks. The hills and ridges, in many cases, are composed of limestone. After leaving the rolling flat, the west-flowing rivers invariably enter a gorge in sedimentary rocks before emerging in the Central Plain. Those rivers bear the semblance of being antecedent streams, although their physiographic relations could have resulted from the protection afforded by the hard layers like the limestone, in inclined sedimentary rocks with different resistances to erosion.

Continuing down stream, along the Badbaran, we find the Binangonan limestone, conformable on the Coal Measures. Two prominent limestone ridges, the highest in this zone, mark the change, from the lower hills of the Coal Measures. The western ridge presents a bold fault scarp trending about north 70° east. Between the two ridges there are some sandstones and some shales which are probably responsible for the existence of two ridges instead of one.

Conformably overlying the Binangonan limestone is a series of intercalated limestone, shale, and sandstone beds, and in places fine conglomerate. This is the Badbaran formation, which underlies the low hills immediately east of the town of Dumarao. Some coral-reef limestone has been observed among these low hills. They may be remnants of Pliocene coral reefs unconformable on the underlying rocks.

From Dumarao westward to Mount Paning Raon, no outcrops are visible for about 2 kilometers, the area being a flood plain covered with soil and alluvial material several meters thick. In some of the small streams which have dug their beds 3 or 4 meters below the plain, shales have been observed.

After the flood plain, the Guadalupe formation of Pliocene age is next encountered. It consists of tuffs, tuffaceous sediments, and some fossiliferous limestone, which make up the low hills bordering the western side of the flood plain. These hills have accordant levels and are about 15 meters higher than the present flood plain. In places small patches of Pliocene coral reefs have been observed outcropping below the tuffs. The tuffs are the last sediments of the syncline with a west dip of about 10° in this section. They are, however, unconformable on the older formations and are in fault contact with the east-dipping limestone in the barrio of Alipasiawan, constituting the downthrow side of a normal fault tending about north 15° east.

The east-dipping limestone just referred to is the edge of the structural unit of the vicinity of Mount Paning Raon; an irregular domal uplift due to an intrusion of a porphyritic basic igneous rock. This uplift was modified by two normal faults; one, the above-cited fault and the other along San Miguel Creek at the foot of Mount Paning Raon itself, almost parallel to each other. They were produced after the intrusion, probably as a result of settling after the injecting forces were spent.

Under the limestone a thick sandstone with a broad outcrop was observed, making up a big part of the ridge immediately east of Mount Paning Raon. Mount Paning Raon itself is capped with about 100 meters of limestone which dips towards the north under the alluvium of the town of Dumalag, but in its western and southern sides this sandstone and some shales are exposed between the igneous intrusion below and the limestone above. Unfortunately, on account of the faults, this sandstone is probably too deep to be available as a source of artesian water in Dumarao. Besides these faults may have obstructed the circulation of underground water in the sandstone.

Westward from Mount Paning Raon along the section to Panay River and beyond it, we find hills and ridges made up of the intruded basic igneous rock, which in some places is basaltic. This mass of igneous rock covers a moderately extensive area west of Mount Paning Raon. Along its borders small areas of sedimentary rocks are found outcropping here and there with very irregular altitudes.

RECOMMENDATIONS FOR DUMARAO

The only town in the above cross section is Dumarao, Capiz. It is immediately underlain by 3 to 4 meters of loose alluvium, which is much too shallow to be a potential source of artesian water. The Badbaran formation comes next under the alluvium, if indeed there are no remnants of any Pliocene sediments or coral reefs. The Badbaran, as has already been noted, is not considered a good water-bearing formation. If a well were dug it would have to pierce approximately 150 meters of the Badbaran to reach the Binangonan limestone.

There is a chance that the Binangonan limestone might be able to supply artesian water, if it is porous enough below the ground-water level. Of all Tertiary sediments it is considered the most important source of water, but this does not mean that it is a positive source. Going through about 130 meters of this formation the drill would encounter shales and then sandstones

which might contain water. After this, there is more limestone for a depth of about 150 meters and then the hole will be in the Coal Measures. As has been said,[16] in spite of the sandstones and conglomerates in the Coal Measures, it cannot be depended upon for artesian water. Besides the well would already be about 300 meters deep, and it might have to go deeper to reach potable water.

Structural conditions and topographic relations are favorable. The rocks outcrop in the hills just east of Dumarao, and they dip west towards the plain. The annual rainfall is more than sufficient. There are good cap rocks, but it is doubted if there are good reservoir rocks. Nothing can be said about the quality of the water either except that, according to Pratt,[17] wells dug below 165 meters in Panay are generally brackish or salty.

In spite of the apparent lack of good reservoir rocks and the probability that the water may be brackish, I would recommend the drilling of a test well in Dumarao to a depth limit of 350 meters.

OTHER SOURCES OF WATER

Rivers.—There is always plenty of water in the rivers, but it is never safe to drink without boiling. Besides, after a rain, it becomes very muddy and must be filtered. Many people depend on this especially during the dry season.

Springs.—Near the town of Dumarao itself, there are springs, but about 4 kilometers southeast of Dumarao there is a place named Tirum where a small stream of water comes from a limestone outcrop and which has been under consideration for some time as a source of water for Dumarao. It may not be a true spring, but a small underground river. It has been estimated that it would cost about 50 pesos per kilometer of pipe to bring the water to Dumarao, which is very moderate. The source of the water is about 20 meters higher than Dumarao, providing enough head for the flow of water; but during the dry season, when water is most needed, there does not seem to be a sufficient amount.

People in the hills far from the rivers generally live near springs. Springs are of course more plentiful in the region of low hills, especially where the strata are tuffaceous sediments or porous limestone, than in the lowlands. The springs

[16] Pratt, W. E., loc. cit.
[17] Loc. cit.

are generally very small, but since there are only a few families depending on any one spring, the supply is adequate.

Shallow wells.—There are plenty of shallow wells, especially at some distance from streams. These wells are only 1 to 3 meters deep in the soil and alluvium and are easily contaminated by surface waters.

Rain water.—Rain water continues to be the best and safest drinking water. Dumarao does not boast of a town storage tank, and during the dry season there is a sad lack of rain water.

SECTION THROUGH DUMALAG

Section B–B′ goes through Dumalag and Buntog, an important barrio of Dumalag, where the railroad station and the public market are situated. Because this section goes through many kilometers of the flood plain of Panay River, there is no outcrop except in the hills across Panay River and in the hills of the eastern part of the area. The section was, therefore, made by projecting the structure of the region just south of it where outcrops are more plentiful. It cannot, of course, be very accurate.

There is enough evidence from the topography and hydrography that the two faults in the Mount Paning Raon dome affect this section, but the dome itself may not be in evidence since the limestone of Mount Paning Raon seems to dip to the north under the alluvium of Dumalag. There should be, therefore, just a broad syncline modified by faulting. East of Buntog the structure should be much the same as that east of Dumarao, only it is more extended and there may be two faults near the eastern edge of the area, trending about north and south.

West of Dumalag, across Panay River, the sediments generally dip to the east away from the igneous rocks. Crystalline limestone, coral limestone, sandstones, and shales are found intruded by a basalt related to the Mount Paning Raon intrusion. The lower hills with accordant summit levels are underlain by tuffs and tuffaceous sediments. The alluvium under Dumalag and Buntog is in all probability not less than 30 meters.

RECOMMENDATIONS FOR DUMALAG AND BARRIO BUNTOG

Recent alluvium, when thick, is a very important source of artesian water in the Philippines. Since the alluvium under Dumalag and Buntog is probably not less than 30 meters thick it is a potential source of artesian water. Several years ago some very shallow pumping wells were drilled in the alluvium

in Dumalag with an average depth of about 12 meters. They supplied part of the population with drinking water until the pumps were worn out, and the wells were abandoned. These wells were undoubtedly too shallow. I would recommend the drilling of wells in Dumalag through the alluvium and casing the well 2 to 3 meters from the bottom of the alluvium. A depth of about 30 meters is probably safe enough to insure moderately sterile waters. Bacteriological analyses of the water should be made from time to time. The same is recommended for Buntog. In the Asturias Sugar Central, near Buntog, a well is drilled to a depth of about 50 meters. According to the driller, only shales were encountered. It seems to me that they went too deep. The alluvium should be made the source of the water. It is possible, however, that the alluvium is not as thick under Buntog as under Dumalag.

Structural conditions and topographic relations are about the same as the section across Dumarao, as far as ground-water circulation is concerned, except that the syncline is much broader here. The stratification is probably identical in the two cases; but since the syncline is very broad and the succession of strata is not definitely known, I would hesitate to recommend a deep well into the older sediments, if water can be secured from the alluvium.

OTHER SOURCES OF WATER

What has been said before regarding river water and rain water applies to the other sections. In Dumalag, like Dumarao, there is no storage tank for rain water, but some are being planned for Buntog, because of the success of the public market there.

Springs and underground rivers.—Springs abound in the hills, especially at the contact of igneous and sedimentary rocks, but on account of their location only a few people are benefited.

Suhut.—About 2 kilometers south of Dumalag, at the foot of Mount Paning Raon on its northern side, an underground stream comes out of the limestone caves at a place called Suhut. It is a popular spot for bathing parties and picnics. The municipality is even thinking of erecting a bath house there. It has also been proposed to pipe the water to the town, but I doubt if there is sufficient head.

It happens that this underground stream is a distributary from San Miguel Creek which enters the limestone caves from

the other side of Mount Paning Raon. People with carabaos and other animals live near the headwaters of San Miguel Creek and consequently the water should be as contaminated as the ordinary river waters. The water going through the limestone caves should also be high in phosphates on account of the guano in the caves.

The caves at Suhut contain a great quantity of alluvial material of igneous origin. This shows that they were and some still are channels of underground streams which enter from the other side of Mount Paning Raon where igneous rocks also outcrop.

I would suggest that bacteriological analyses be made of the water at Suhut. The results will show whether or not a bath house should be erected.

There is a sulphurous spring at Suhut which is thought to be medicinal, and many drink the water. Its lamentable feature is that many people scoop water from the little square well around the spring, and pour it over themselves. The water thus poured often drains back into the well from which others drink. No doubt sulphur waters are good for skin diseases, but the public should be protected by some sanitary and foolproof device at this spring.

SECTION THROUGH SUMMIT AND ODELL'S RANCH

There is no town or large barrio along section C–C′, but a discussion of it is inserted here for the purpose of correlating the structure and the stratigraphy of the different sections.

Starting from the east, where the igneous rocks make up some low irregular hills, and going westward, along Lamunang River one encounters a rolling flat underlain by both basalt and the westdipping sediments of the Coal Measures. Then the river flows through a cañon in the Binangonan limestone which here gives rise to a prominent ridge. After this the Badbaran formation is seen until Summit flag station on the railroad is reached. From Summit the tuffs are seen dipping west and underlying a moderately high flat. About 1 kilometer from Odell's ranch some shales and tuffs were observed with an east dip. A normal fault has been crossed and the structure is now part of the intruded dome of Paning Raon. The hills behind Odell's ranch are mostly made up of Binangonan limestone. As one continues west, shales and tuffs are encountered dipping away from the Paning Raon structure; then an igneous intrusion is observed in a creek in the barrio of Nueva Union. It

is believed that the San Miguel Creek fault continues through this locality.

SECTION THROUGH PASSI AND CALINOG

Section D–D′ starts from Mount Caniapasan and ends at Calinog across Jalaur River. Between Passi and Calinog there is a sad lack of outcrops because of the low rolling plains with alluvial deposits of the Jalaur and the low hills underlain by tuffaceous sediments. Here I have merely projected on this section the structure of the region north of it, eliminating, however, the dome structure of Paning Raon.

Mount Caniapasan is a mountain made up of fine-grained to porphyritic basic igneous rock. Going westward, lower hills of basalt are encountered, after which a low rolling plain is reached underlain by basalt, and the older sediments of the Coal Measures. A few small hills are made up of hardened conglomerates. The sediments have a general westward dip.

The plain is succeeded by the ridge of Bayebaye, which is composed of very porous coralline limestone. Other ridges to the south, like Camiri Hills and Putian Ridge are also made up of corals. These are probably Pliocene coral reefs. The Binangonan limestone and the Badbaran formation were not seen outcropping. It is possible that they underlie the alluvium of the central plains.

West of Bayebaye Ridge, sink holes are common, implying the presence of cavernous limestone below. Shales and tuffs come next, all with a general westward dip, underlying Passi below the thin alluvium present there. About 7 kilometers west of Passi on the road to Calinog a fine hard conglomerate was observed dipping also to the west. It looks like the old conglomerates of the Tertiary series. On the Jalaur, at Calinog, the axis of the syncline was discovered in tuffs and tuffaceous sediments. The axis trends about north 10° east. The dips on both sides amount to 18°. The syncline is modified by the two faults already referred to in the other sections. West of Calinog the tuffs and other sediments outcrop in the foothills of the Cordillera of Panay.

RECOMMENDATIONS FOR PASSI AND CALINOG

Only recently an unsuccessful well was bored in Passi to a depth of 700 feet and encountered nothing but shales. It had to be abandoned because the drilling outfit could not go any deeper. From the cross section it is estimated that the depth

to the coralline limestone which outcrops at Bayebaye is about 300 meters or nearly 1,000 feet. The sink holes east of Passi imply the presence of this limestone below Passi, and since it is very porous and full of cavities, it is very probable that it will be a good source of artesian water. If a well is dug it may have to be pumped, as there is probably not sufficient head to produce flow. I would recommend, therefore, the drilling of a well in Passi until the limestone is reached at about 300 meters. Nothing can be said as to the quality of the water. The alluvium in Passi is probably too thin to be a source of artesian water.

At Bayebaye there is an underground stream which issues from the limestone. This has been under consideration as a source of water for Passi. The water will have to be piped about 4 kilometers. The source of the water, of course, must be protected from contamination.

North of Passi, at Maasin, there is a salt spring from whose water salt used to be obtained in the earlier days. This might imply that the deep waters may be salty or at least brackish.

What has been said about rain water, rivers, springs, and shallow wells applies to Passi also.

Calinog is right on the axis of the broad syncline of the Central Plain of Panay, a very favorable location for flowing artesian wells. It is built on tuffs and tuffaceous sediments which are generally very porous and which outcrop in the hills west of Calinog. If cap rocks are present, flowing wells should be obtained. A great number of successful wells in the Philippines, many of them flowing, were drilled in this formation.

I would recommend the drilling of a test well in Calinog to a depth of about 200 meters or to where water is encountered at a moderate and safe depth.

GENERAL CONCLUSION

From the study thus far completed, it is found that the towns are all in a broad synclinal plain, a favorable location for artesian wells, especially as the rocks in this syncline outcrop in the hills on both sides. Rainfall seems to be abundant enough to keep the rocks well supplied with water all the year round. Probably the greatest drawback is the fact that good reservoir rocks are not abundant, the Tertiary sedimentaries being poor sources of artesian water, as a rule. Moreover, one can never tell whether the water will be fresh or brackish. In spite of these unfavorable features, I recommend the drilling of test wells in the localities above mentioned.

ILLUSTRATIONS

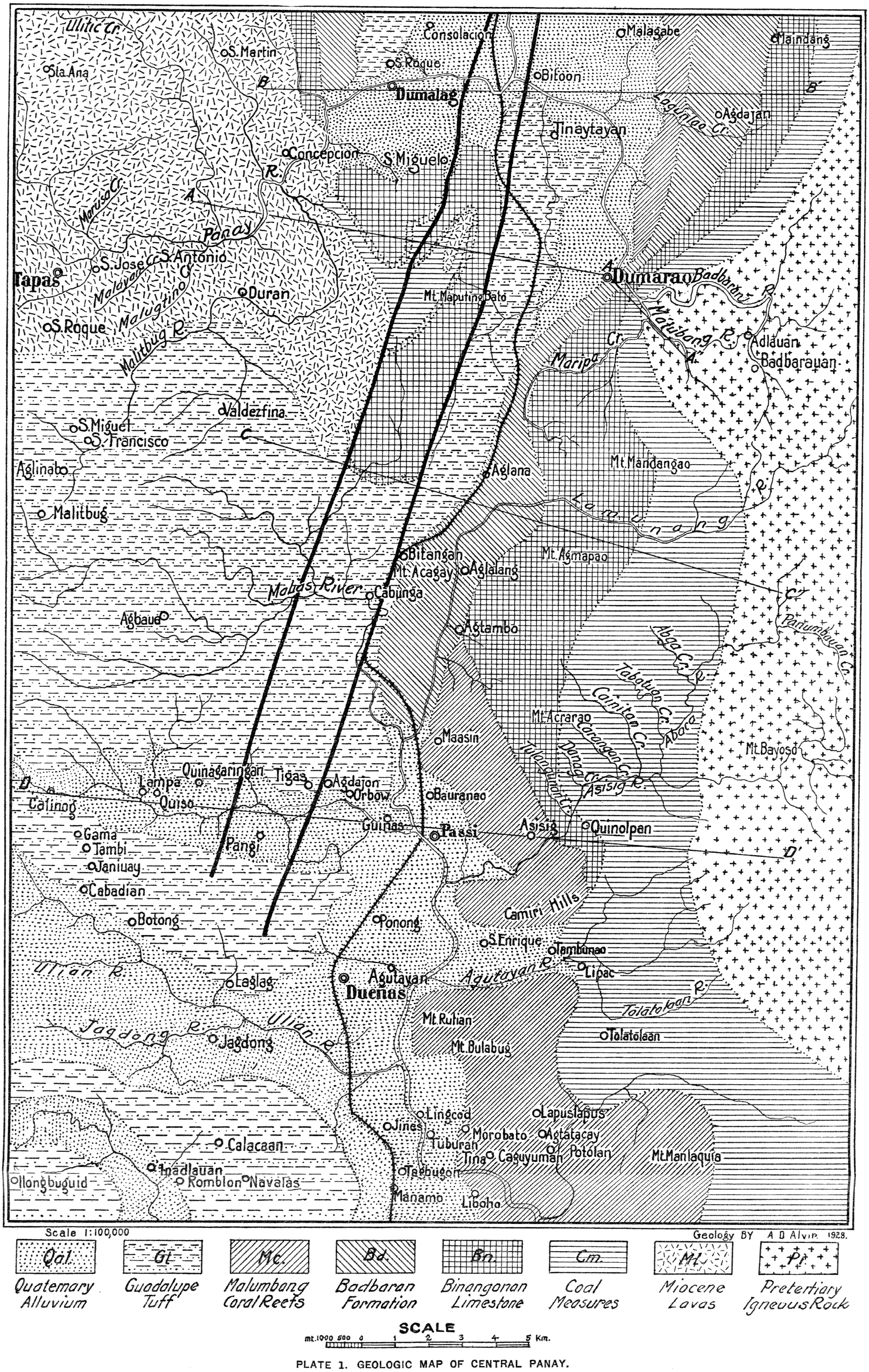
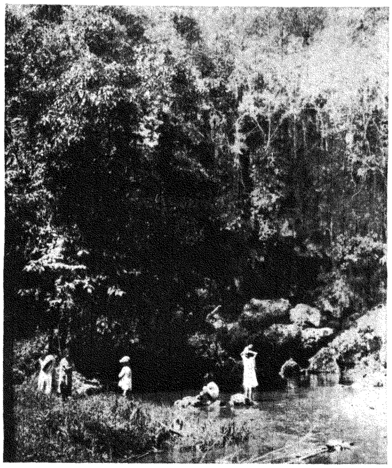


PLATE 1. GEOLOGIC MAP OF CENTRAL PANAY.



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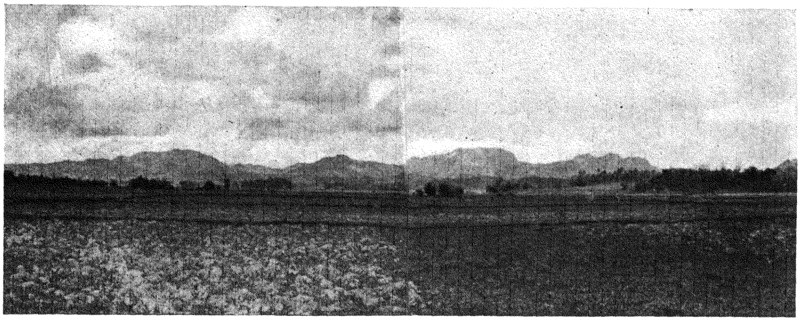

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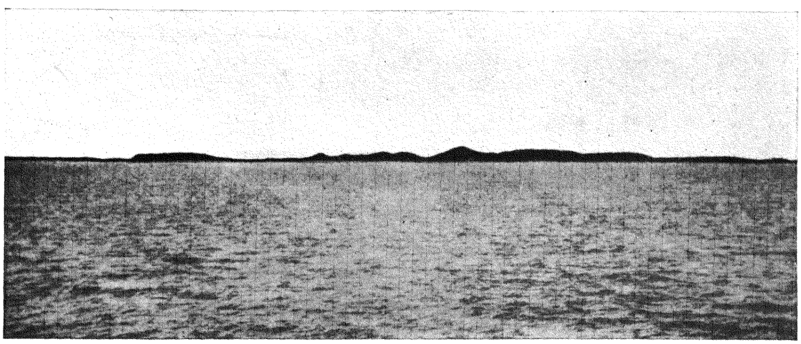

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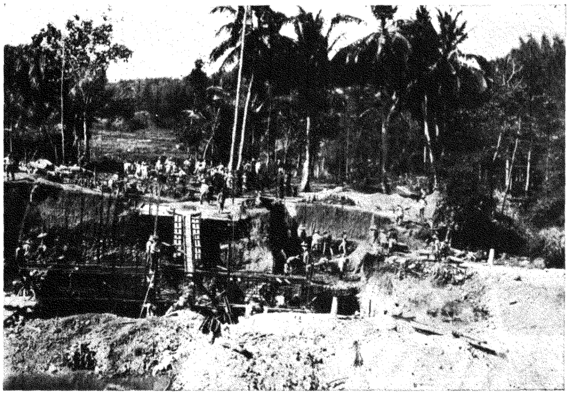
PLATE 2.



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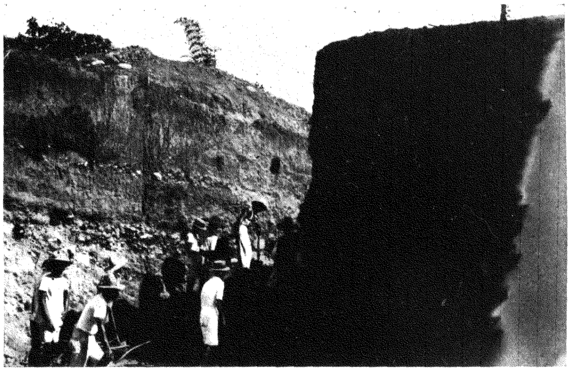

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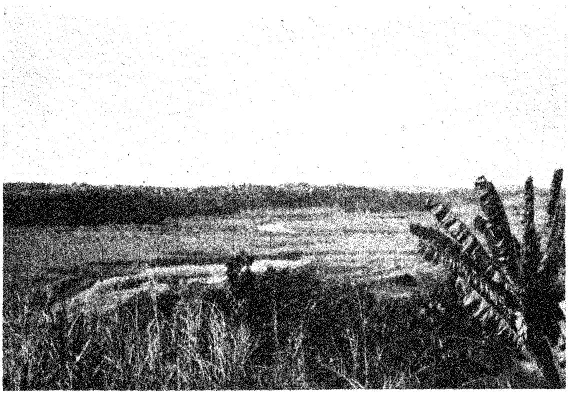

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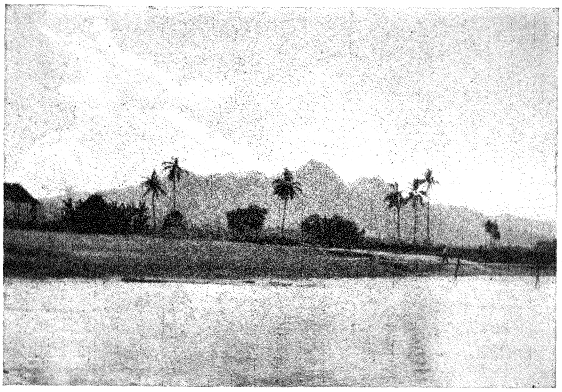

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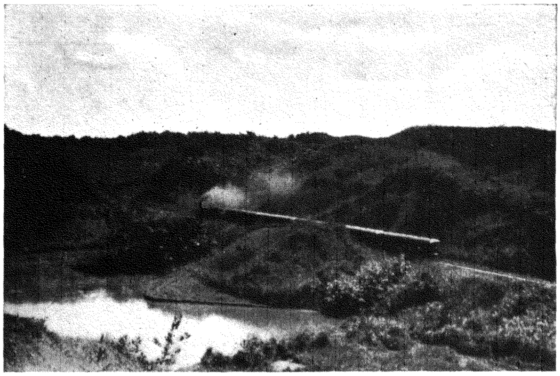

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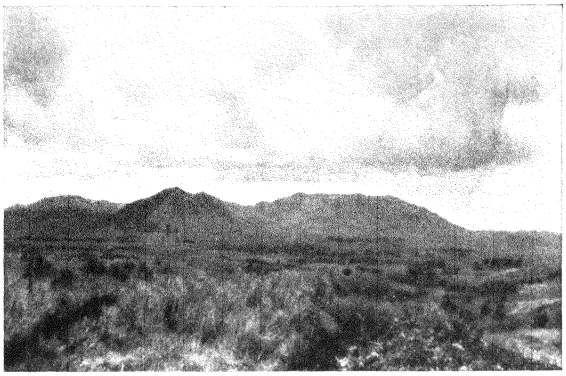

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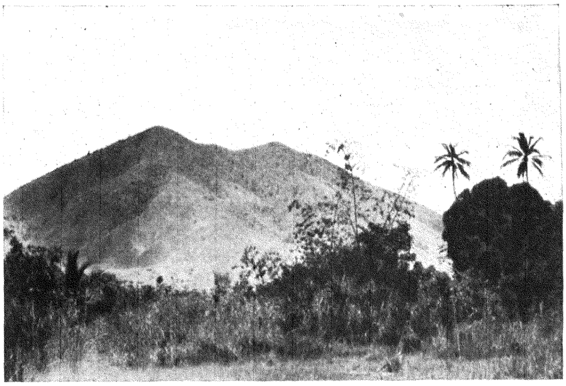

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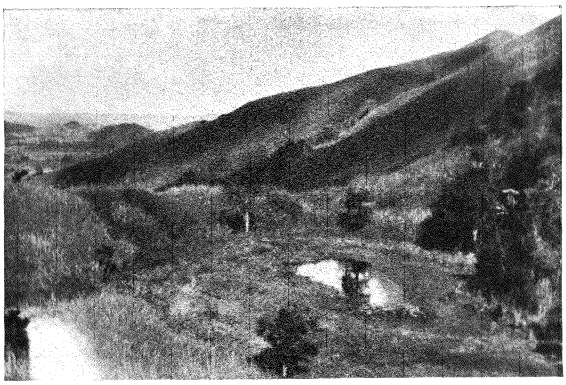

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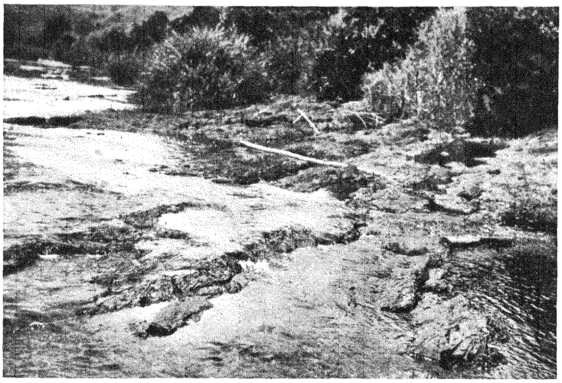

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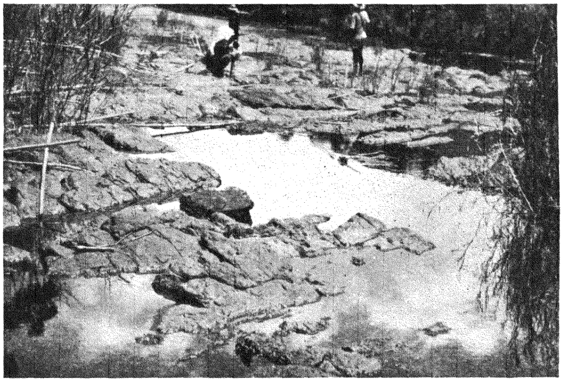

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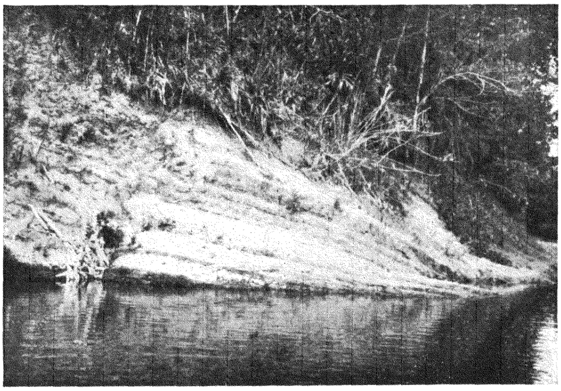

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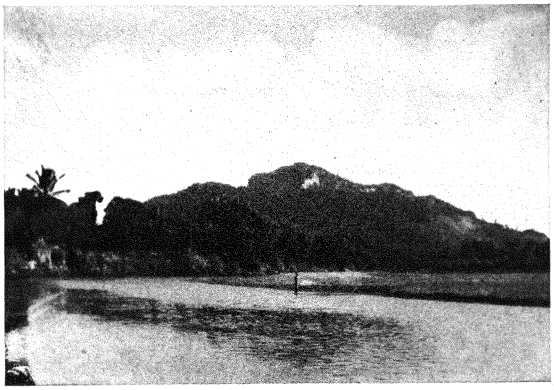
PLATE 6.



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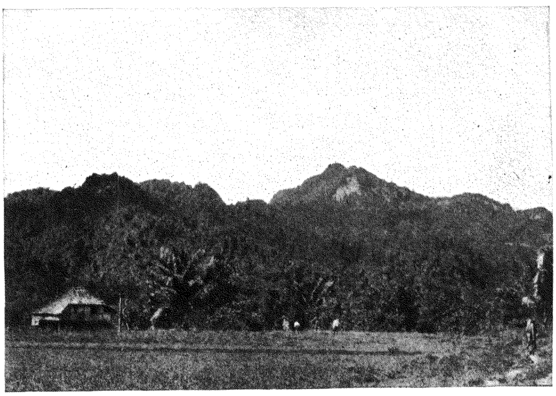

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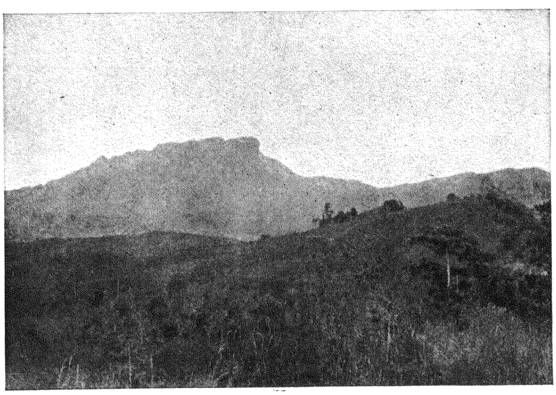

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THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 42 AUGUST, 1930 No. 4

TWO JAPANESE FISHING METHODS USED BY JAPANESE FISHERMEN IN PHILIPPINE WATERS

By HERACLIO R. MONTALBAN and CLARO MARTIN

Of the Division of Fisheries, Bureau of Science, Manila

EIGHT PLATES AND SEVEN TEXT FIGURES

THE MURO-AMI FISHING METHOD

An important and unique fishing method introduced into the Philippines by Japanese fishermen is the *muro-ami,* which is attracting attention because of the success with which it has been used in the Philippine waters and because of its great effectiveness in capturing fishes that Filipino fishermen have not been able to catch in such large quantities.

Financial success in the operation of this method by the Japanese has also been reported from the Federated Malay States, Java, and other East Indian countries, and in the Philippines it is by far the most effective fishing gear for taking coral-reef and rocky-shoal fishes. There are about a dozen outfits in use in the Philippines, operating from such centers as Manila, Batangas, San Jose in Mindoro, Culion, Cebu, and Iloilo. Powered boats are employed to handle the muro-ami, and at present their operation covers a vast area from Lingayen Gulf to Mindanao and Sulu Archipelago.

A muro-ami unit consists of a parent ship or motor boat manned by Filipino crew, Japanese fishermen, three or four bancas, a net, lines and pendants, eyeglasses or goggles, and a "water telescope." The motor boat is from 8.78 to 51.85 gross tons and is provided with a crude-oil engine of 20 to 80 horse power. The number of Filipinos employed depends upon the

tonnage of the boat, and usually a patron and a chief engineer are engaged. From fifteen to twenty-five Japanese are needed to operate by this method.

Japanese fishermen have discovered remarkably rich fishing grounds in the Islands, and usually they maintain a station, near these grounds, in some barrio or municipality, from which they hold a license for the privilege of fishing in waters within its jurisdiction. When sufficient fish are caught the motor boat returns to Manila or to one of the market centers referred to above to dispose of the fish, to obtain provisions, and to buy sufficient block ice for the preservation of the catch, leaving all the fishing equipment and most of the fishermen at the station. While waiting for the return of the motor boat, the Japanese repair, dry, and tan their net and put the bancas and other fishing implements into perfect working condition.

On the return trip, the motor boat goes to the station, before proceeding to the fishing grounds. For short trips the bancas are simply towed behind, but for long trips and when the sea is a little rough and the wind strong they are carried on board. Upon arrival at the fishing grounds, the boat is directed from place to place, as near rocky shoals or coral reefs. Parties are sent out in bancas to make observations on the abundance of fish, strength of the tidal current, nature of the bottom, etc. With the aid of the "water telescope," which is usually a wooden bucket with glass bottom partly immersed in the water, the bottom of the sea can be plainly seen from the banca. Several fishermen are ordered to jump into the water to determine the direction and strength of the current, by means of the movements of the pendants or streamers attached to their lines. The goggles not only protect the eyes but also enable the fishermen to determine the kind of sea bottom and the presence of fish. According to the fishermen, the dominant factors in choosing a site for the fishing operation are the presence of an abundance of fish, clear water, quiet to moderately rough sea, and not excessively strong current.

The net, of cotton, is composed of three main parts: namely, the bag and the two wings. The mouth of the bag has a circumference of about 188 feet, and on land its length from the rim of the opening to the tip of the closed end measures nearly 180 feet. One-fourth of the opening serves as the cork line and is provided with wooden floats set very close together at the middle and up to 4 inches apart on the outer portion. The lead, or

bottom, line, which is a little heavier than the cork line, covers nearly half the mouth circumference; it is a 1-inch rope provided at each end with a 25-pound stone with no intervening weights. The bag net it made from No. 19 twine, and the meshes measure 1.25 inches when stretched. Each wing consists of several pieces of rectangular net, and usually as many as ten pieces are used. Each piece is 56 feet 3.6 inches long and 34 feet 10.8 inches deep (fig. 1). When the net is laid near an island, the wing next to the land is made shorter.

Ropes of the same sizes as those for the bag are used as cork and lead lines for the wings. The floats, 0.5 inch thick and almost 5 inches square, are irregularly set at from 6- to 12-

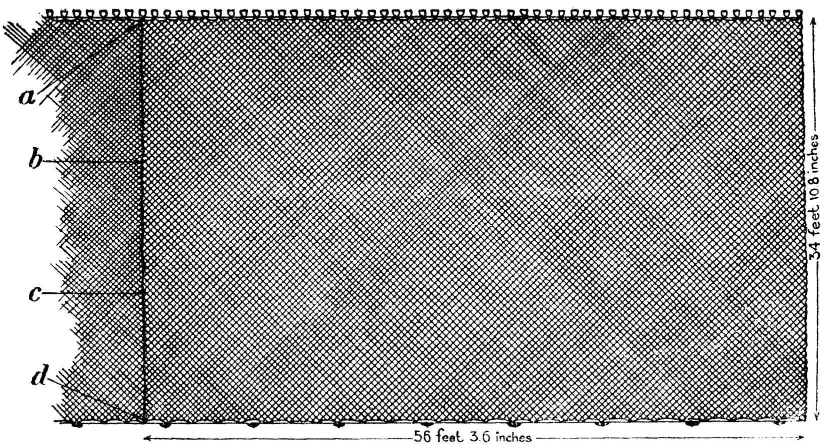


FIG. 1. One piece of the muro-ami net, showing on the left how it is joined to another by sedge or balangot straw (*a*, *b*, *c*, *d*).

inch intervals. When the net is in use 2-pound stones to serve as weights are tied to the lead line about 6 feet apart. The wings are of No. 21 twine, and the meshes measure uniformly 3.25 inches when stretched. In other outfits two weights of twine are used, the coarser one for the strip 6 feet around the rim of the bag opening and next to the cork line of the wings (fig. 2).

The net is set in reefs and shoals where the water is from 3 to 10 fathoms deep. In shallow places where the water is just as deep or less than the net the float line naturally will stay at the surface, but in deeper waters where the net is often laid the float line is usually submerged and the ground line always touches the sea bottom. The method is just as effective

whether the float line is or is not submerged, in as much as the gear is intended to catch fishes that are habitually bottom dwellers.

In laying out the net, the bag is set first with the opening facing the current. The closed end is lowered, followed by the cork and bottom lines. Five or six men jump into the water to hold up the body of the bag, and at the same time they carry

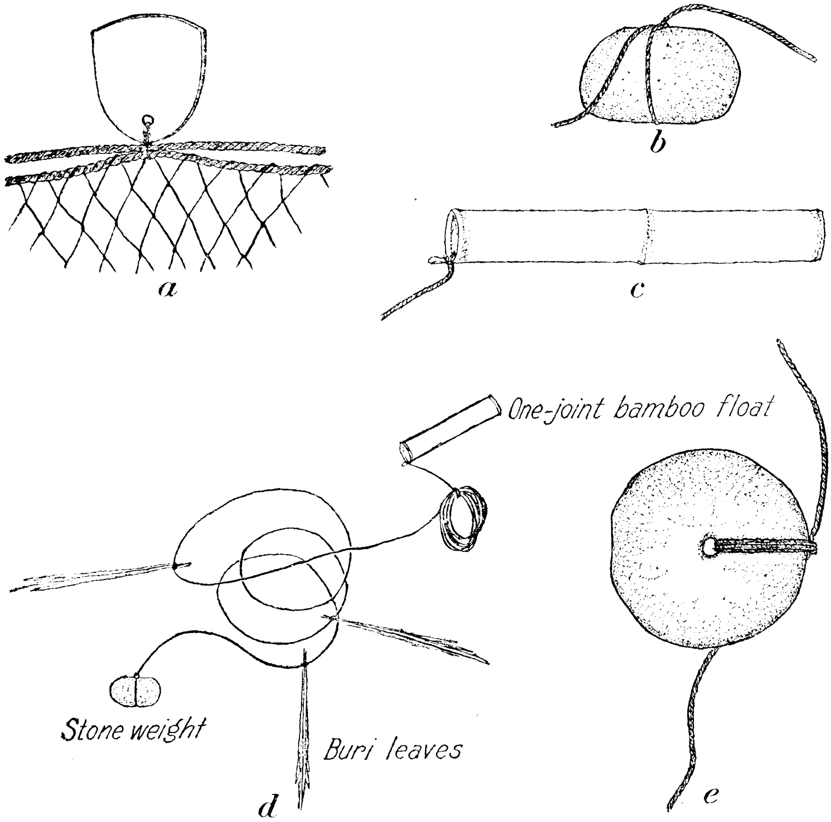


FIG. 2. Accessory parts of muro-ami outfit; *a*, wooden float; *b*, 2-pound stone weight; *c*, two-joint bamboo buoy; *d*, pendant; *e*, 25-pound disklike stone weight.

forward the open portion so as to let the net spread out to its full length. Two 25-pound stones are tied to the bottom line, one at each end with about 30 feet between the stones. The free ends of the bottom line are held in two bancas, each of which is anchored on each side of the opening of the bag. At times anchors or large stone weights are used to keep the closed end of the bag distended. This is done only when the net is set with the closed end of the bag facing the current or when

there is no current at all. A banca containing one wing of the net sets out to a point about 300 feet away, and the fishermen throw into the water the buoy and weight and rapidly lay out the net until one side of the bag is reached. The other wing is laid out in a similar manner by another banca at the opposite side, making an angle with the first so that the distance between their outer or free ends is from 300 to 600 feet. When the bag, net, and wings are ready for operation, all the fishermen board two bancas, each of which goes towards the outer end of a wing; the men, in turn, jump into the water until all of them form an arc covering the distance from one wing to the other. Each fisherman uses tight-fitting eyeglasses, or goggles, which enable him to see under water, and carries a weighted line provided with a buoy and marked at intervals near the lower end with pendants or streamers of strips of young buri or coco-palm leaves. While advancing, the swimmers make as much commotion as they can and jerk their lines up and down in order to frighten the fish into the bag. Sometimes the men dive to see that no fish break back and thus avoid the net. When the fishermen are about 30 feet from the bag, four or six of them board two bancas, which lie anchored near the opening, and lift the bottom line; at the same time the others continue to advance until the open end is brought to the top in order to prevent any possible escape of the fish. More men help to haul in the net, which is worked out between the two bancas. The fish caught are then scooped up by means of large dip nets and placed in a third banca which takes them to the launch anchored not far away. The fish are placed on the deck first, and when time permits they are sorted according to kinds and sizes. Usually those that command high prices are put together by themselves. The fish are then taken to the compartments in the hold where they are packed in crushed ice. While this is being done the rest of the fishermen busy themselves taking up the wings, lines, and buoys to prepare for another layout (fig. 3).

Sometimes a different layout of the muro-ami is executed. Instead of letting the wings open, the whole net is used to surround a small reef or rocky shoal where fish are observed to congregate. The wings are drawn in gradually towards the bag until a very small space is left in the inclosure, and with the aid of the lines and pendants Japanese fishermen drive the fish into the bag.

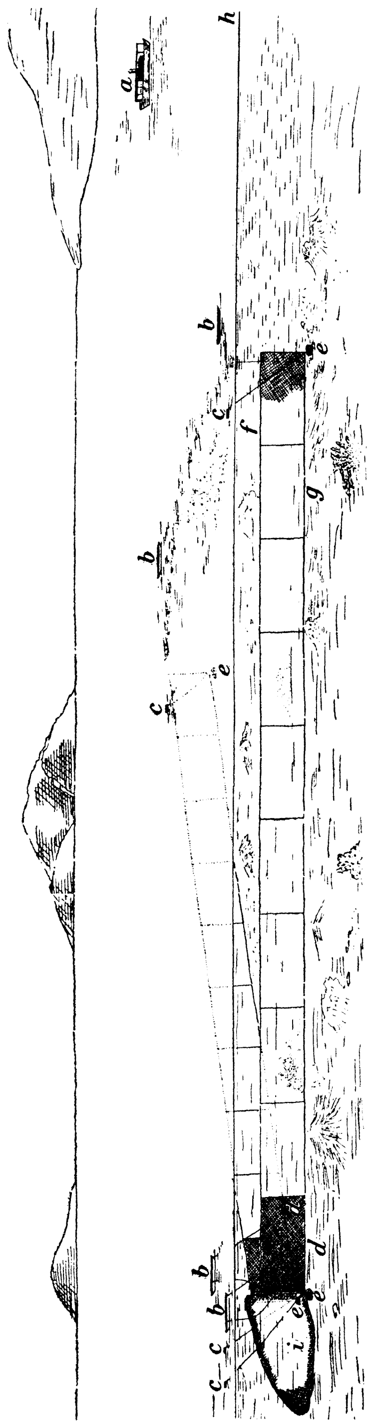


FIG. 3. The muro-ami in operation; *a*, motor boat; *b*, banca; *c*, bamboo buoy; *d*, anchor; *e*, 25-pound disklike stone weight; *f*, float line below water level; *g*, lead line touching sea bottom; *h*, water level; *i*, bag net; *e* to *e*, wing.

Fishing takes place close to the shore or on some isolated shoal or bank far from land, frequently at a depth of not over 10 fathoms. Oftentimes a haul can be made in less than an hour, and the size of each haul depends on various conditions. In one instance Japanese fishermen operating from Iloilo made a fare of 4,400 pounds of fish from a single haul. In some cases with two or three good hauls they are able to catch sufficient fish to fill the hold of the motor boat. Ordinarily five or six trips to the fishing grounds are made each month, and during each trip two or three days are actually spent in fishing. During this short period from 5,500 to 16,500 pounds of fish are caught. Since the whole catch cannot be disposed of at once in the market, the fish are kept in cold storage in the ice plant.

The fish mostly caught by this method is caesio, or *dalagang bukid.* In fact the net is purposely constructed for this group of fishes from which it derives its name of muro-ami, or caesio net. However, other fishes that are reef and shoal dwellers are caught in large quantities.

Among these are the surgeon fishes, or *labahita* and *indangan;* porgies, or *bakoko;* snappers, or *mayamaya;* groupers, or *lapo-lapo;* big-eyes, or *malaking mata;* rudder fish, or *ilak;* and siganids, or *samaral.* Sometimes large quantities of barracuda, or *rompe candado,* and of several species of pampanos, or *talakitok,* that happen to come within the range of the net are trapped. In many cases each haul brings in a number of parrot fishes, or *molmol;* wrasse-fishes, or *maming;* puffer fishes, or *botete;* trigger fishes, or *papakol;* and goatfishes, or *saramollete.* Before the advent of this means of capture the dalagang bukid, indangan, labahita, ilak, and samaral were exceptional fishes in Philippine markets, but at present large quantities of them are supplied by the Japanese at moderate prices. They are fine food fishes in every way; but in some localities, like Iloilo and Manila, they are not so popular as in Cebu.

When small catches are made or when unfavorable conditions occur, especially during the southwest monsoon, some muro-ami outfits go to such a fishing center as Estancia, Panay, where they buy from Filipino fishermen large quantities of sardines which they sell in Manila or Iloilo.

A motor boat is indispensable in the use of this method, because the fishing grounds are usually very far from the markets. With a motor boat, fishing trips requiring an absence of several days or weeks from the station or markets can be made; deck room, cargo space, and facilities for equipment and the handling of the catch are provided; and the rapid marketing of the fish is assured. Due to marked financial success attained by Japanese fishermen in the use of this means of capture, there is an increased activity among them to add to the present number new and better boats.

The muro-ami method is not employed by Filipino fishermen, although it has been in operation in Philippine waters since 1920. It is very simple and not difficult to operate, but can only be carried on by vigorous and hard-working men. A number of Filipinos have tried to work with the Japanese in operating this net, and there is no doubt that the native fishermen, given the same equipment, can be equally successful.

THE UTASE FISHING METHOD

In Manila Bay trawl fishing has been carried on by Japanese fishermen who employ about sixty sailing boats at present.

Each of these boats carries a crew of four or five fishermen and operates five to seven trawls in the water at a time. The boats are the ordinary type of Japanese sailing sampans, varying in size from 6.61 to 17.6 gross tons. Of late, some fifteen of them have been equipped with crude-oil engines and are used not only for fishing but also to distribute supplies, fish trays, and water among the other fishing sampans in the open sea, to tow these from Manila to the fishing grounds, and to transport the catches to the shore.

The fishermen have formed an organization known as the "Japanese Fishermen Association" which has its office in Manila. All matters that have direct bearing upon this particular fishery are handled by this office. A lot is maintained for the convenience of the Filipino laborers that are employed as cargadores, boatmen, tanners, and carpenters. In this lot general repair work in connection with the fishing outfit is done. When not fishing, the boats are anchored off Tondo beach just north of the lighthouse at the mouth of Pasig River.

The beam trawl is the style used and is called "utase" in Japanese. The beam from which this trawl gets its name is made of bamboo and is employed for the purpose of keeping the mouth of the net spread. It is held in a horizontal position a short distance off the ground, and supports both wings of the trawl net. In operation, the upper edge of the mouth is buoyed up by the wooden floats of the float line, and the lower edge is kept next the bottom by the weight of the ground line and by that of the net itself, there being eleven stone weights on the lead line of the anterior portion of each wing.

The net is composed of four parts; namely, the triangular top, the wings, the funnel, and the bag. The whole net is made from hemp, *cannabio sativa*. Except for a small portion at the bottom of the mouth, the net is generally of No. 18 twine. The mesh is coarsest in the small portion just referred to and finest in the cod of the bag (fig. 4).

The hem of the triangular top is about 12 feet long and 16 feet, stretched taut, at its greatest depth. The float line, made from a fiber similar to coir, forms the boundary between the triangular top and the wings together with the bag. The float line measures almost 36 feet long. There are thirteen floats in all, arranged as in fig. 4; each is about 1 foot long, 2 inches at its widest portion, and 1 inch thick at each end. The floats are set closer as they approach the mouth of the bag, and the

intervals between them vary from 1 foot to about 2 feet. The bottom line consists of two ropes (fig. 5) the ends of which are tied to the corresponding ends of the float line. A length of about 6 feet is allowed at the outer end of each wing to serve as a wing bridle. A wooden brail 1.5 feet long, employed to stretch up the fore part of the wing vertically, is fastened to both the float and bottom lines. The weights of the bottom line consist of twenty-two stones, each of which weighs about 2 pounds. There are eleven weights to each side. From the outer end of the wing the first weight is $1\frac{1}{3}$ feet from the second; the spaces between the rest of the weights are uniformly 2 feet.

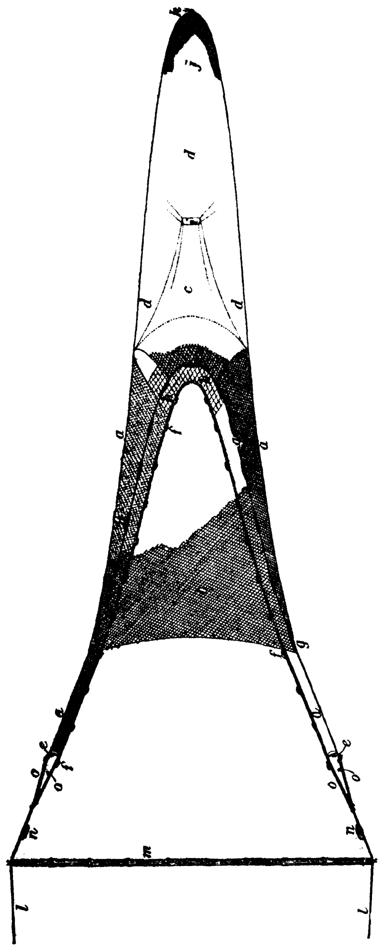


FIG. 4. Details of a trawl net; *a*, wing; b, anterior portion of the triangular top; *c*, funnel; *d*, bag; *e*, wooden brail; *f*, stone weight fastened to the bottom line; *g*, wooden float; *h*, the rectangular portion of heavier twine and coarser mesh at the bottom of the mouth of the bag; *i*, opening of the funnel; *j*, fine-meshed cod of the bag; *k*, the cod end closed and tied with a draw string; *l*, portion of the main bridle; *m*, beam; *n*, 25-pound stone weight; *o*, wing bridle.

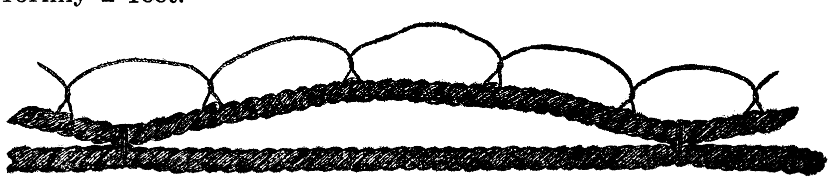


FIG. 5. Bottom lines of the trawl net.

Each wing is made up of five pieces of net ranging in depth from about 2 to almost 8 feet. Between the innermost divisions of the wings at the upper center of the mouth of the bag is a rectangular piece of netting, 2 feet in width, having a 1.25-inch

mesh. A similar piece, of coarser mesh and heavier twine, 5 feet long and 2 feet wide, is present also on the opposite side. From these two parts the bag narrows rapidly to the fine-meshed cod end, which is so arranged that it can be unlaced to discharge the catch when it is hoisted aboard the operating boat. The bag itself is 16.5 feet long, stretched taut from the end of the upper rectangular piece. Each trawl has a funnel, 5 feet long, which leads into the bag. Its end is held open by means of four short lines tied to the bag in such a way as to make a square opening. The funnel is of the same size of twine and mesh as the greater portion of the bag.

The bottom line of the trawl is made from Japanese rice straw and has a diameter of 0.75 inch. Rice straw is used because it is a cheap material. As already stated, this line consists of two ropes extended 6 feet at each end to serve as a wing bridle. One side of the main bridle is 138 feet long. Each trawl is provided with a very long tow line, and each of the four outer nets has an auxiliary tow line. The tow line is attached to the bamboo beam, 18 feet long, by means of the main bridle. A short distance from where the main bridle is tied to the wing bridle, a disk-shaped stone weight of 25 pounds is fastened. Another weight of the same kind is tied to the tow line a short distance from where it joins the main bridle.

The fishing boats usually leave port for the open sea at about 1 o'clock in the afternoon; although some pull out earlier and others even as late as 5 o'clock, depending upon the tide and wind. The motor boats generally depart at 3 o'clock to distribute the supplies and trays to their respective fishing sampans, and when this work is done they head towards some favorable grounds where the nets are laid out.

At the fishing grounds the sampan is placed at right angle to the wind. In order to counterbalance the action of the wind which tends to tip the boat leeward, a big barrel suspended from a lever on the windward side is filled with water. After the stone weights, beams, bridles, and tow lines are properly fastened, the nets are lowered. In laying out each net the bag is thrown overboard first, leaving the outer ends of the wings on the deck. The beam that keeps the wings open is fastened at the proper place and then lowered, one end after the other. Nets 1 and 6 (fig. 6) are first set out at the same time, followed by nets 2 and 5, and nets 3 and 4 are laid out last, one after the other. The bridle and the tow lines are let out a little at a time. After a certain length of the lines is laid out,

the sails are raised a little to catch wind in order that the boat starts to move, thereby stretching the lines. This prevents the occurrence of a slack which may cause entanglement of the various tow lines. As shown in fig. 6, nets 1, 2, 5, and 6 are tied fast to booms projecting from the bow and stern, by means of auxiliary tow lines that are about 10 fathoms in length. When not in use the booms are partly pulled in. When the wind is not strong, only three or four trawl nets are used and the tow lines are shortened, making it easier to drag the nets; but when the wind is blowing hard the other nets are lowered and the

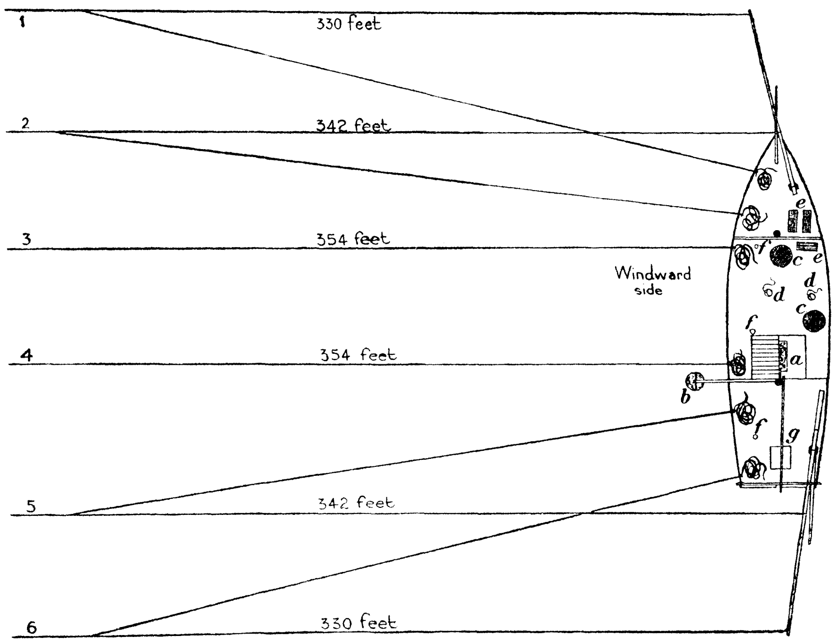


FIG. 6. The two lines shown in relation to the boat; *a*, engine room; *b*, barrel filled with water; *c*, coarse, round, shallow baskets; *d*, pails; *f*, kerosene lamps; *g*, kitchen.

usual length of the tow line is paid out. At present several motor boats operate single large trawls which are towed behind.

By the time the trawls are all down, the two main sails are almost fully spread and the boat is allowed to drift with the wind and current, thus dragging the nets over the sandy and muddy bottom. At times the two auxiliary sails at the bow and the stern are also hoisted. Every now and then the spread of the sails is regulated according to the force of the wind. Right after each drag is completed, which requires from four to eight hours, the trawl nets are drawn in and lifted by hand power.

Usually the fishermen begin to pull in their nets at 8 o'clock in the evening, but if the wind is strong fishing is continued for about two or three hours longer. As a rule the middle trawls are hauled first.

After the catch is unloaded on deck, it is sorted according to kinds and sizes. The fish are placed in round, coarsely woven, bamboo baskets in which they are washed with sea water. After the washing, the contents of the baskets are placed in shallow bamboo trays, which are piled one on top of another, ready for the motor boats to take to Manila. Each motor boat attends to a number of sister fishing sampans, which by means of a combination of lights are easily distinguished from the others. The motor boat goes from one sampan to another to get their catches

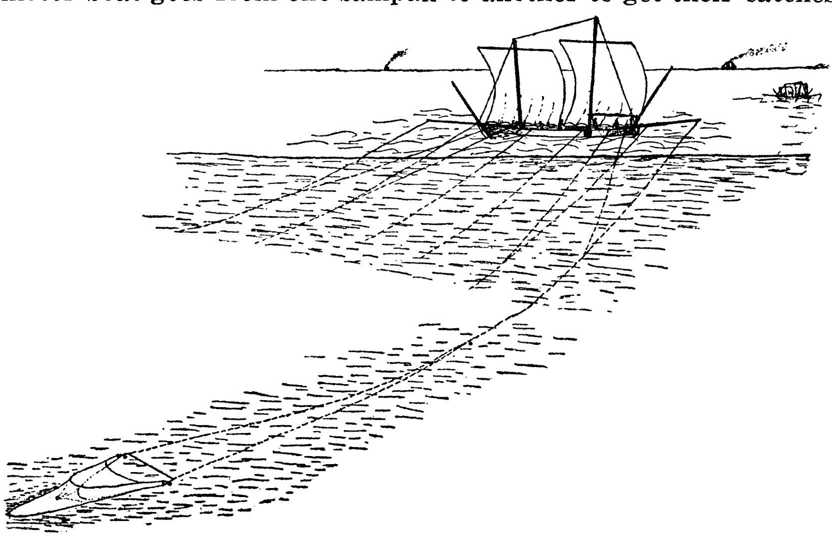


FIG. 7. An utase outfit in operation.

and carries these with all possible haste to San Nicolas district, Manila, reaching there usually before 5 o'clock in the morning. The trays are landed on long flat-bottomed bancas, and from these they are transferred to the storehouse where the fish are covered with crushed ice. After the icing, the fish are taken to Divisoria Market where they are sold to the retailers for the different markets of Manila.

The utase method is best adapted to catching fishes frequenting sandy, clay, or muddy bottom. Mostly shrimps, slip-mouths, or *sapsap,* and *Nemipterus,* or *besugo,* are taken. The balance of the catch includes flatfishes, or *palad;* lizard fishes, or *kalaso;* goatfishes, or *saramollete;* cutlass fishes, or *laying;* flatheads, or

sunog; grunts, or *agu-ut;* mojarras, or *malakapas;* and whitings, or *asohos.* Sometimes small quantities of young pampano, or *talakitok,* and sea bass, or *lapolapo,* and also of crabs, or *alimasag,* are accidentally captured.

Trawling is practically all done in the open waters of Manila Bay at a depth up to 20 fathoms. Most of the bay is an excellent trawling ground, the bottom being of clay, mud, and sand. As far as bottom-feeding fishes are concerned, conditions in these waters are remarkably favorable. Over the whole area of the trawlable sea bed, the Japanese fishing fleet seems to be able to trawl fish.

The work of the fishermen is exceedingly trying, and practically during the entire year they are out fishing in their boats in Manila Bay, their time at home being on stormy days and on special Japanese holidays. The utase is an old-style beam trawl, yet it is superior in many respects to any of the local methods for catching shrimps and fishes feeding along clay, muddy, and sandy bottom. There is considerable speculation on the part of the Filipino fishermen as to the success of this method, but results in this fishery, as shown by the increased number of the utase fishing boats and the installation of auxiliary motors in several, indicate a marked progress. The fact is that fishing with the utase is not so expensive, because few men are employed and wind power is used for dragging the nets. There is no reason why Filipino fishermen cannot engage as successfully as the Japanese in this particular method of fishing.

ILLUSTRATIONS

PLATE 1

FIG. 1. A Japanese muro-ami fishing motor boat operating from Cebu.
2. Loading ice for preserving the catch.
3. Loading the net into the banca which is towed by the motor boat.

PLATE 2

FIG. 1. Laying out the net.
2. Hauling in the bag net.
3. Bailing the fish from the bag net.

PLATE 3

FIG. 1. Filipino crew of a muro-ami outfit.
2. A haul of caesios (dalagang bukid).
3. A haul of surgeon-fishes (labahita and indangan).

PLATE 4

FIG. 1. A haul of caesios (dalagang bukid), siganids (samaral), surgeon fishes (indangan and labahita), rudder fishes (ilak), big eyes (malaking mata), etc.
2. Drying and mending the muro-ami at the station.

PLATE 5

FIG. 1. Partial view of the lot in Azcarraga maintained for general repair work in connection with the fishing outfit of the Japanese fishermen in Manila Bay.
2. Another partial view of the lot in Azcarraga, showing the way the nets are dried.

PLATE 6

FIG. 1. View of the deck of a motor boat on the way to the fishing grounds to distribute supplies, trays, nets, etc.
2. Distributing trays to one of the sampans.

PLATE 7

FIG. 1. A close up view of one of the fishing sampans anchored off Tondo beach, with the nets being dried.
2. Portion of the fishing fleet anchored off Limay, Bataan, after the night fishing.
3. Portion of the fishing fleet anchored off Cavite, passing the afternoon and getting ready for the night trawling.

PLATE 8

FIG. 1. Preparing for the night trawling: tying the bottom line of the trawl.

2. Preparing for the night trawling: tying stone weights to the bottom line.

TEXT FIGURES

FIG. 1. One piece of the muro-ami net, showing on the left how it is joined to another by sedge or balangot straw (*a*, *b*, *c*, *d*).

2. Accessory parts of a muro-ami outfit; *a*, wooden float; *b*, 2-pound stone weight; *c*, two-joint bamboo buoy; *d*, pendant; *e*, 25-pound disklike stone weight.

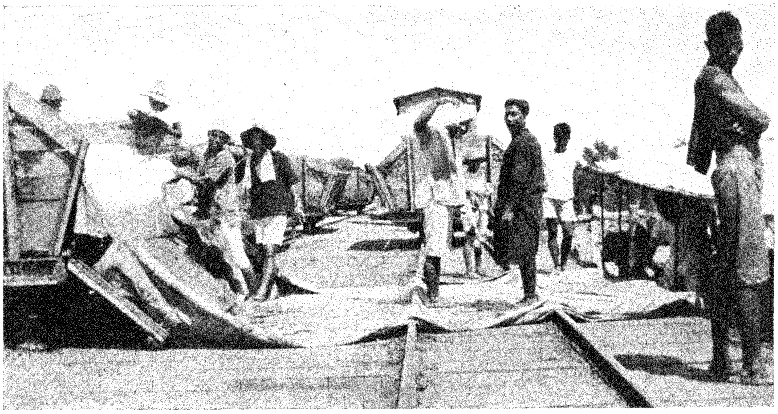
3. The muro-ami in operation; *a*, motor boat; *b*, banca; *c*, bamboo buoy; *d*, anchor; *e*, 25-pound disklike stone weight; *f*, float line below water level; *g*, lead line touching sea bottom; *h*, water level; *i*, bag net; *e* to *e'*, wing.

4. Details of a trawl net; *a*, wing; *b*, anterior portion of the triangular top; *c*, funnel; *d*, bag; *e*, wooden brail; *f*, stone weight fastened to the bottom line; *g*, wooden float; *h*, the rectangular portion of heavier twine and coarser mesh at the bottom of the mouth of the bag; *i*, opening of the funnel; *j*, fine-meshed cod of the bag; *k*, the cod end closed and tied with a draw string; *l*, portion of the main bridle; *m*, beam; *n*, 25-pound stone weight; *o*, wing bridle.

5. Bottom lines of the trawl net.

6. The tow lines shown in relation to the boat; *a*, engine room; *b*, barrel filled with water; *c*, coarse, round, shallow baskets; *d*, pails; *f*, kerosene lamps; *g*, kitchen.

7. An utase outfit in operation.



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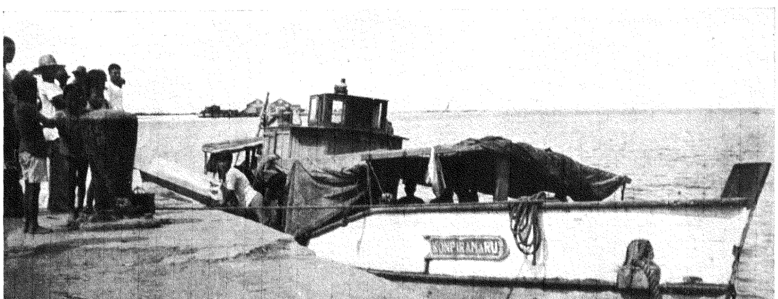

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PLATE 1.

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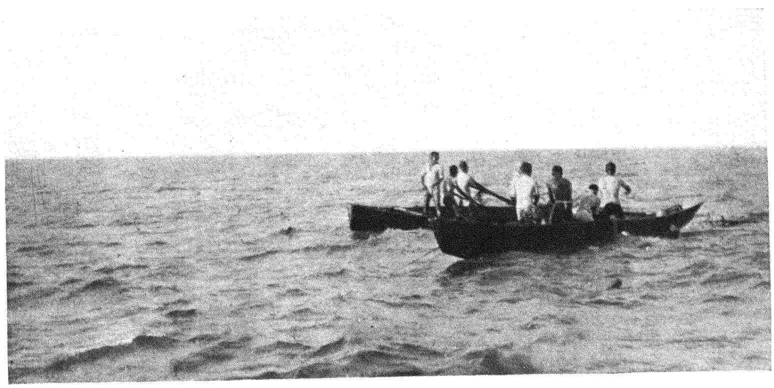

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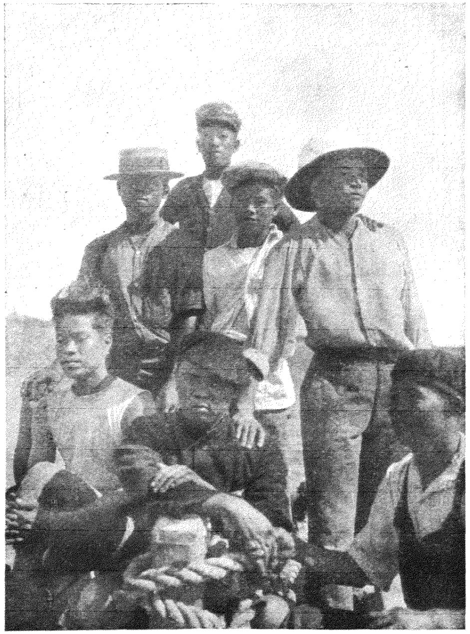

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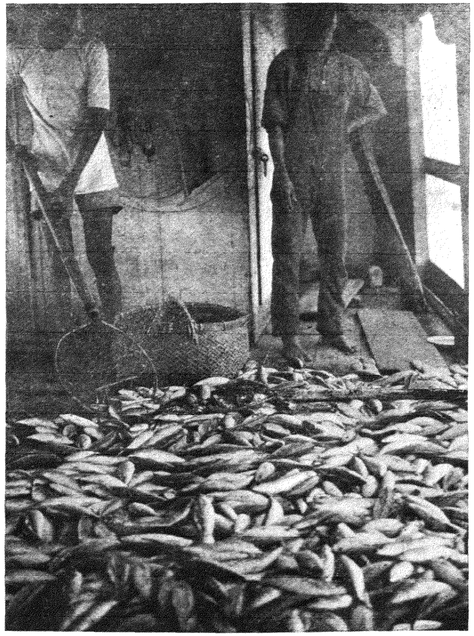

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PLATE 3.

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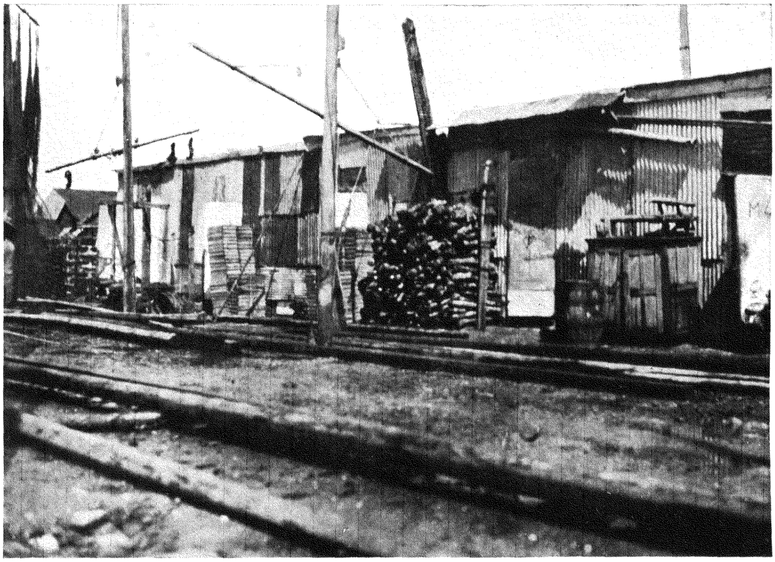
PLATE 4.



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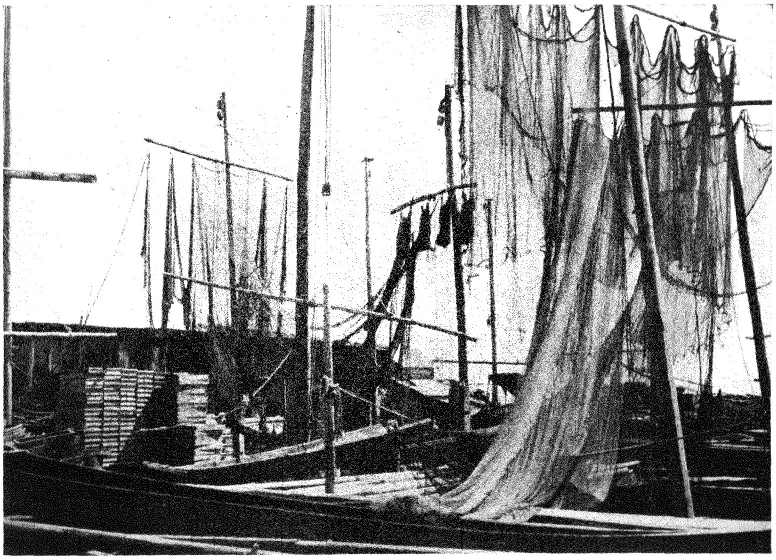

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PLATE 5.

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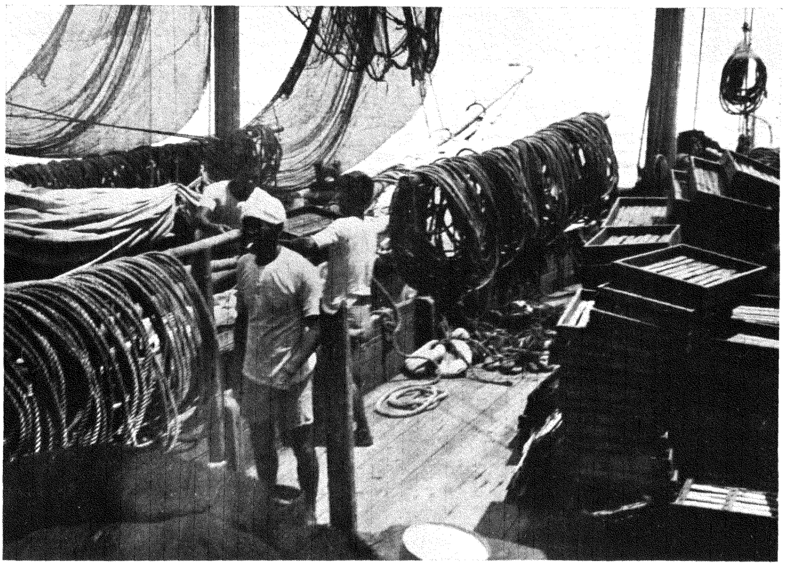

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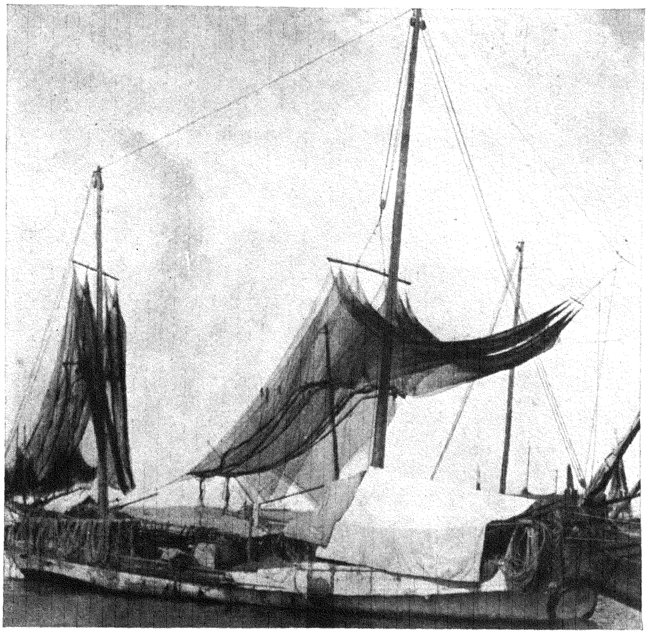
PLATE 6.



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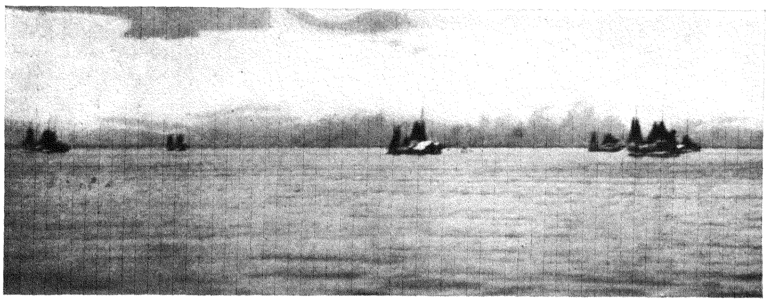

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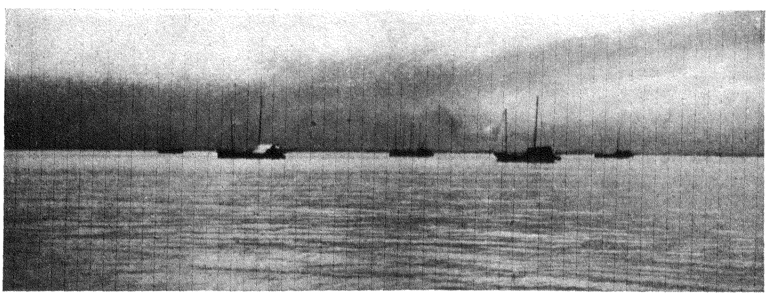

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PLATE 7.

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PLATE 8.

THE PRESERVATION OF MALARIAL OÖCYSTS AND SPOROZOITES

By C. Manalang

Of the Philippine Health Service, Manila

FOUR PLATES

One of the most important findings in the studies on malaria transmission during the past twenty years is the demonstration that not all anophelines are natural malaria vectors although many of them may be infected and become infective artificially. During the past two years, in more than 49,000 dissections of over ten species, only *Anopheles minimus* Theobald showed regular infections of the stomach or salivary glands. One *A. vagus* Donitz was found infected in the stomach in 10,500 examinations of the *A. vagus-subpictus* (*rossii*) group.

It has also been shown that a species may be an important natural vector in one country or part of a country and not in another, or found infected during certain months of the year only, for reasons still not well understood. In over 7,000 dissections of *A. ludlowi* Theobald, we failed to find a single positive. In Java this species is the most important vector. Banks's mistake about his positive finding in this species in 1907 has been alluded to in a previous article.[1]

These findings have led to species control in localities where only the preferential breeding places of the proved vector are treated in the attempt to reduce malaria. The importance of the examination of wild-caught adult anophelines of different species from malarious stations for natural infection is, therefore, very evident, particularly so in the Philippines, where larval control is under test, with at least fifteen species of *Anopheles* and where no work of this kind has been attempted. Banks's[2] and Walker and Barber's[3] investigations were confined to experimentally infected mosquitoes.

[1] Manalang, Philip. Journ. Sci. 37 (1928) pl. 4, fig. 10.

[2] Philip. Journ. Sci. § B 2 (1907) 513–536.

[3] Philip. Journ. Sci. § B 9 (1914) 381–439.

Such work should be persistent for years and should use as much material as can be efficiently handled by the available personnel, for only then can the accumulated data be considered reliable. Since most of the mechanical part of our work had to be entrusted to technicians, only careful men were trained. They were constantly supervised, checked in species identification, interpretation of findings, and instructed in the mounting and preservation of positive and questionable material for file or subsequent confirmation, should the responsible party be away from the laboratory.

We failed to find in limited available literature methods of preparing malaria-infected stomachs and salivary glands for permanent preservation or microphotography, and to support our work with such records we tried various means. Those found satisfactory will be given presently and should help beginners. The methods are not new, being based on known laboratory procedures. The method of isolation of the stomach and salivary glands has already been described [4] or may be found in most texts on tropical medicine.

All the specimens used in illustrating this article were isolated and almost all mounted by technicians, and several of the microphotographs were taken by one of them.

STOMACH

A freshly isolated positive stomach may be photographed in normal saline solution under a cover glass with good results if the microphotographic apparatus is at hand, but waiting and jarring may distort or break the oöcysts (Plate 2, fig. 4).

Formalin mount.—Float the specimen in a large drop of saline and cover with a cover glass. Under a low-power ($\frac{2}{3}$) objective, with a dissecting needle, roll the stomach by pushing the cover glass until the oöcysts are brought to the edge of the specimen. Carefully apply filter paper to the saline rim beyond the edge of the cover glass to draw the saline and cause the cover glass to flatten the organ. If its position changes, apply a large drop of saline to the edge of the cover glass, which will refloat it; place the oöcysts in position by repeating the above process. After a time, before the saline dries out, place a drop of 3 to 5 per cent formalin in water on the edge of the cover glass. The formalin will levitate the cover glass with the stom-

[4] Philip. Journ. Sci. 37 (1928) 123–131.

ach attached to it or to the slide, or it will be left free in the solution, but with the oöcysts permanently on the edge of the preparation due to fixation of the flattened organ. If the specimen adheres to the cover glass, transfer it over a ring of vaseline on a slide with 3 to 5 per cent formalin. Press the cover glass lightly to exclude the excess of formalin and air and close the broken portions of the vaseline. If the specimen is left on the slide, wipe the surface around the specimen dry, ring with vaseline, fill with formalin solution, and cover it. To avoid undue pressure on the specimen, pieces of very fine capillary tubing or strips of cardboard may be embedded in the vaseline. Formalin mounts show the granules in young oöcysts and sporozoites in the matured ones (Plate 1, figs. 1 and 2). Formalin-fixed specimens can be mounted permanently in Berlese's fluid.

Staining.—When the specimen is in position and flattened, it is fixed with Zenker's or Bouin's fluid, as described under formalin mount, for twenty to thirty minutes. Staining is done on the cover glass or slide with the attached specimen. The detached stomach may be attached to a slide, smeared with Mayer's albumin or serum, reflooded with the fixing fluid, and left for an hour or more in a moist chamber (covered Petri dish with wet filter paper in the bottom), after which the slide is washed in water. Precipitate after Zenker's fixation is removed with Lugol's solution and wash. Stain with Delafield's or Mayer's hæmatoxylin until the specimen is dark, a few minutes in Mayer's or overnight in Delafield's. Occasional examination after previous washing in water will show the rapidity of staining. The differentiation is observed under a low-power objective, using the ordinary acid alcohol (used in routine hæmatoxylin-eosin stain for histologic sections) well diluted with water so that it will act slowly. With proper decolorization the oöcysts will stand out prominently, and under a high dry objective ($\frac{1}{6}$), with subdued light, the granules and sporozoites will be distinctly visible; wash in water, pass through graded alcohols, into absolute, with two changes of the latter, clear in xylol and mount in Canada balsam. In iron-alum-hæmatoxylin stain the stomach; after fixation and washing treat with a freshly prepared mordant consisting of 2 per cent aqueous solution of iron-ammonium sulphate for ten to twenty minutes, wash in water, and stain with 0.5 per cent aqueous solution of hæmatoxylin in water for five to ten minutes, until the specimen is black; then wash in water. Differentiation is watched under the micros-

cope, using the same mordant. Wash in water, dehydrate in graded alcohols into absolute, clear in xylol, and mount in balsam. Overdecolorized specimens may be restained. This method is better than the first (Plate 1, fig. 3; and Plate 4, fig. 5).

Microtome sections.—A positive stomach is transferred with a needle into a colorless thin-walled vial, one-third filled with fixing fluid (formalin solution, Zenker's or Bouin's) and the vial is corked. After twenty to thirty minutes, the vial is tilted until the specimen adheres to the side not occupied by the fluid. The fixative is spilt or removed with a pippette and replaced with water. Zenker's fixation should be followed with Lugol's solution, the specimen washed with water, then a few drops of Mayer's hæmatoxylin added. With the specimen adhering to the side of the vial, it may be examined under a low-power objective to observe the progress of staining. Wash with water, follow with graded alcohols, absolute alcohol, and acetone, a few minutes each; chloroform until the specimen sinks, chloroform-paraffin one-half hour; fill the vial with melted hard paraffin and keep in a paraffin oven for two hours; immerse right side up in cold water. Reëmbed the stomach deeper in the paraffin by gently melting about 1 centimeter in the bottom of the vial, turn upside down, and after a while, cool in ice water in the same position. Carefully break the vial, taking care not to leave bits of glass on the paraffin. The paraffin over the stomach is thinly shaved to ascertain the position of the specimen. Cutting at 5 microns, using a Minot rotary microtome, one can get as many as fifty-six longitudinal sections from an empty stomach of *A. minimus*. Sections may be restained or decolorized but a counter stain is not essential (Plate 2, fig. 6).

SALIVARY GLAND

Freshly isolated extra-glandular sporozoites may be photographed at once in saline under a cover glass with good results (Plate 3, fig. 7). Free sporozoites preserved in 3 to 5 per cent formalin are often lost or difficult to find afterwards due to the increase in volume of the medium.

Staining.—When sporozoites are dried in air or fixed in absolute methyl alcohol at the point of drying and stained with Giemsa's, the cytoplasm stains blue and the nuclei red. We failed to photograph such preparations, while hæmatoxylin stains gave good results. The method of staining is the same as for the stomach (Plate 3, fig. 8).

Intraglandular sporozoites appear well when photographed fresh, but not so well when preserved in formalin as they do in matured oöcysts, due to shrinkage and overlapping of the cell walls.

Sporozoites appear poorly in the gland with Giemsa's stain, because the cells take a deep blue stain which obliterates them. Good results were obtained with specimens fixed in absolute alcohol overnight, Bouin's or Zenker's, and stained with hæmatoxylin or iron-alum-hæmatoxylin (Plate 4, fig. 9). Salivary glands fixed in slightly acidulated absolute alcohol (one or two drops of concentrated hydrochloric acid in 100 to 150 cubic centimeters of absolute alcohol) and stained with iron-alum-hæmatoxylin, also show the intraglandular sporozoites well (Plate 4, fig. 10).[5]

We tried to section by microtome a couple of naturally infected salivary glands, but failed. The small size of the gland necessitated the use of a "carrier" such as agar-agar or celloidin, while heavily infected lobes, as a rule, are very fragile and usually rupture upon isolation. In our attempt to detect infections in mosquitoes caught in distant places by serial sections, we obtained satisfactory sections of the glands in many cases (Plate 4, fig. 11), and hope to find positive specimens in situ. Artificially infected insects will probably give better results.

By the methods described, we have preserved on file a good number of positive specimens ready for future reference.

[5] This method was devised by Mr. C. Urbino, of our laboratory.

ILLUSTRATIONS

[Microphotographs 3, 4, 5, 6, 8, 9, and 11 were taken by the Bureau of Science; the others by Mr. C. M. Urbino, of the Philippine Health Service. All of the specimens, except that shown in fig. 11 are from *Anopheles minimus* Theobald.]

PLATE 1

FIG. 1. Formalin mount of a heavily infected stomach; × 100.

2. Formalin mount showing sporozoites in a mature oöcyst; × 500.

3. Positive stomach, Bouin's fixation, stained with iron-ammonium sulphate and hæmatoxylin; × 100.

PLATE 2

FIG. 4. Fresh stomach in saline solution; three of the four young oöcysts are distorted and flattened; × 450.

5. Granular oöcyst in the center and a smaller mature one beside it. Zenker's fixation and stained with iron-ammonium sulphate and hæmatoxylin; × 1000.

PLATE 3

FIG. 6. Five-micron section of a positive stomach fixed in formalin and stained in block with Mayer's hæmatoxylin; × 190.

7. Fresh free sporozoites from ruptured salivary gland, in saline solution; × 1000.

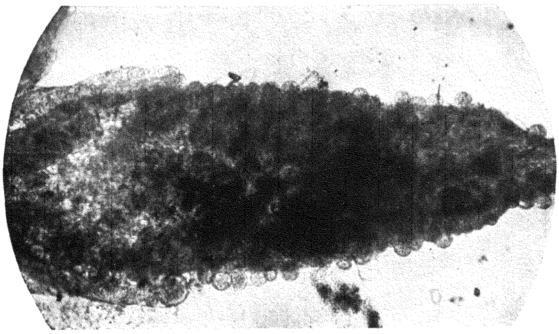
8. Free sporozoites from ruptured salivary gland, fixed in Zenker's solution and stained with iron-ammonium sulphate and hæmatoxylin; × 1000.

PLATE 4

FIG. 9. Intraglandular sporozoites fixed in absolute alcohol and stained with iron-ammonium sulphate and hæmatoxylin. Only one cell in the center is in focus to show the sporozoites; × 1000.

10. Intraglandular sporozoites, fixed in acidified absolute alcohol and stained with iron-ammonium sulphate and hæmatoxylin; × 1000.

11. Ten-micron paraffin section of *Anopheles vagus*, showing four lobes of the salivary glands. Fixed in alcohol and stained with hæmatoxylineosin; × 590.



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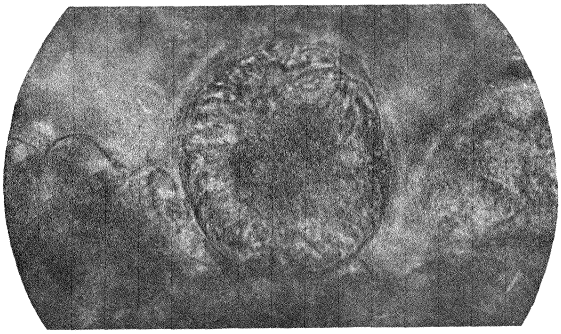

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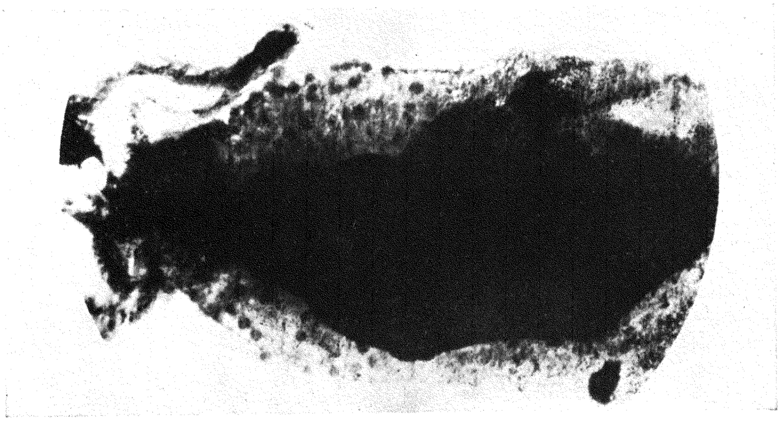

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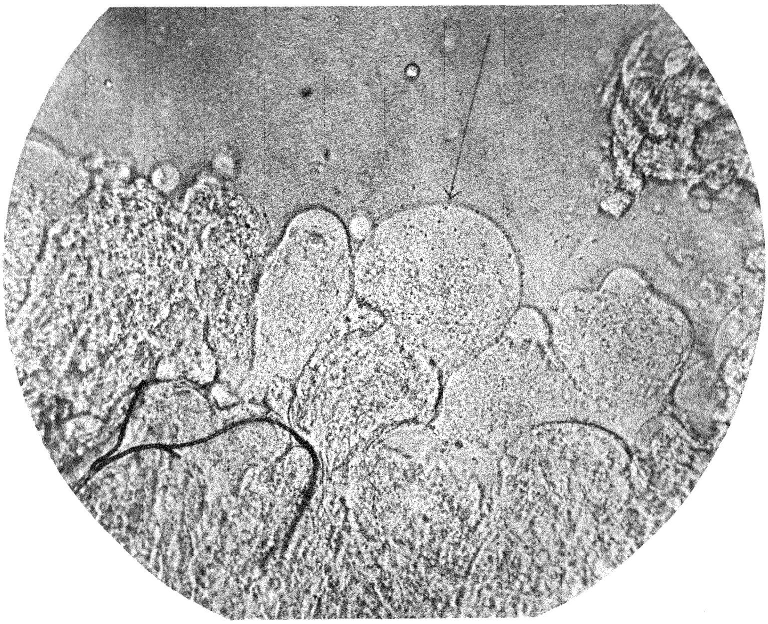

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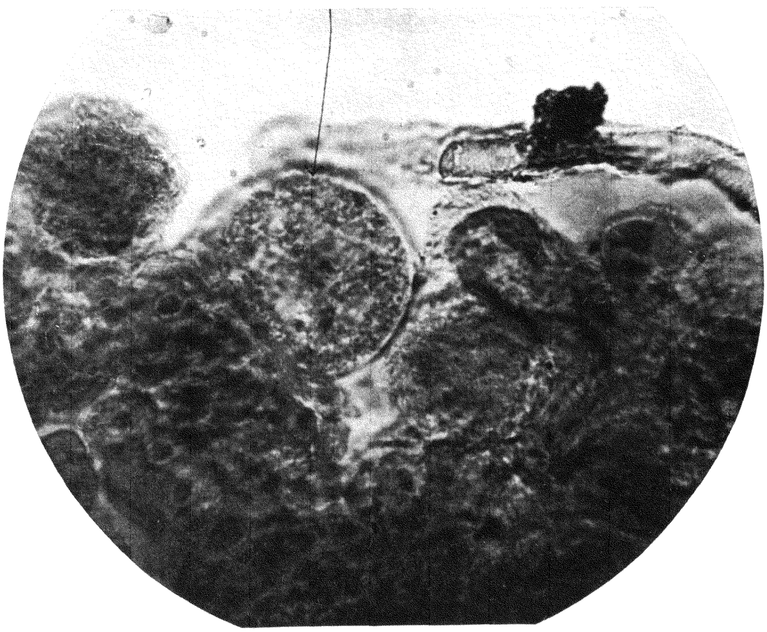

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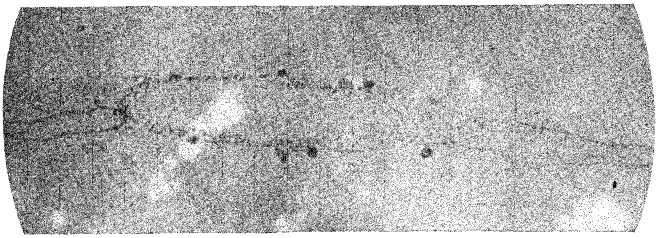
PLATE 2.



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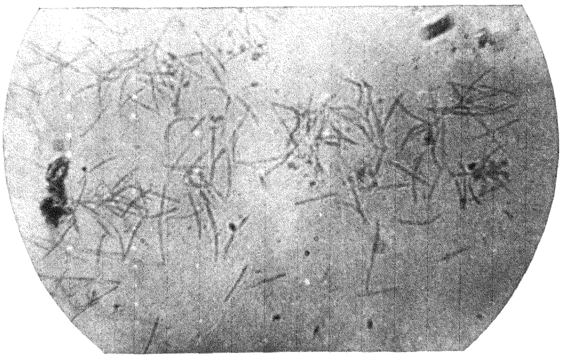

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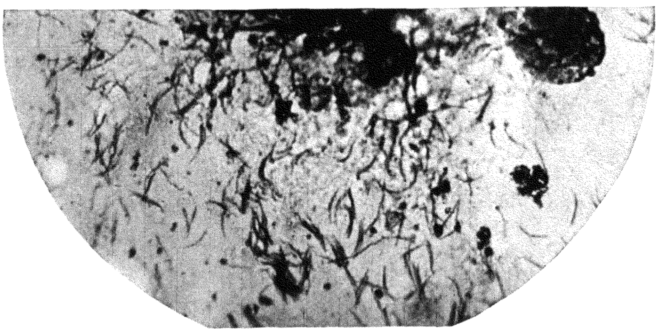

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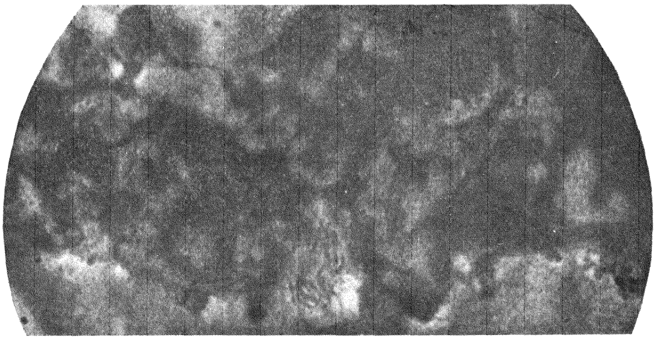
PLATE 3.



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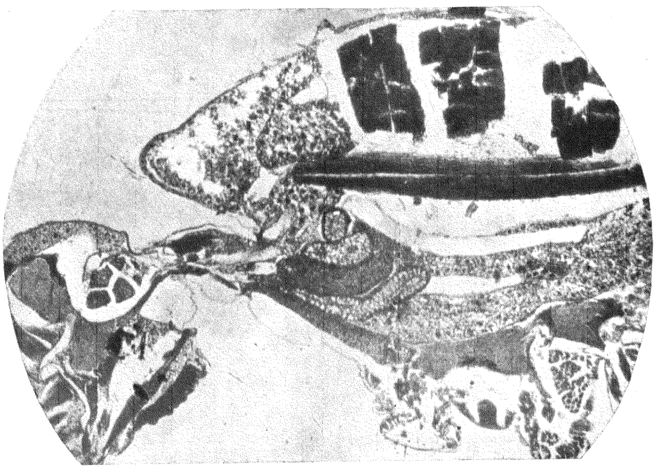

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PLATE 4.

CONGENITAL EYE, NOSE, AND SKULL DEFECTS IN A HORSE

By MANUEL D. SUMULONG

Of the College of Veterinary Science, Los Baños

ONE PLATE

A rather unusual combination of eye, nose, and skull defects observed in a week-old horse is here recorded. While examples of various types of malformations of the head in mammals are on record, yet, so far as I am aware, there has not been a case in equines recorded that resembles the one here described. It is believed that, other than its embryologic significance, the present specimen will prove to be of some interest to animal breeders as well as to veterinarians; it is a fairly good example of aberration in the development of the fœtus that invites economic loss by imperiling the life of the young owing to vital defects in some essential organs.

In the study of the anomalous features presented by this horse the authors cited in the bibliography were consulted.

MATERIAL

The specimen was presented to the Department of Veterinary Anatomy by Mr. Sebastian Salva Cruz, to whom grateful acknowledgments are accorded for making the dissection possible. According to the owner it was the offspring of a native mare, bred to a normal stallion, and so far as he could remember the mare had not met an accident of any kind during pregnancy.

Before the young animal was sacrificed a thorough observation was made. The animal was very lively and appeared to be perfectly normal in size; it presented nothing that would attract attention except its completely closed eyes and markedly deformed face. The head as a whole, though apparently normal in size, was very much distorted; it was asymmetrical in outline and bent towards the left side in its anterior part. Both cheeks were very incompletely developed. The animal was absolutely blind, but the sense of smell and hearing seemed to be perfectly normal. The external ears presented nothing of importance except that the right one was placed farther back than its fellow.

The animal could hardly suck, and, when drenched with milk or water, showed signs of great difficulty in diglutation.

EYE DEFECTS

The edges of the upper and lower eyelids on both sides were completely and permanently fused (cryptophthalmia), the palpebral fissure of each side being indicated only by an oblique faint groove which was overhung by a few cilia or eyelashes. The right eye was somewhat depressed and placed at a higher level than the left one. Upon removal of the eyelids, the left eyeball was apparently normal in size; the only feature that attracted attention was its abnormally thin cornea which was adherent to the internal surface of the eyelids (symblepharon). The internal surface of each right eyelid was found intimately blended with a thick layer of connective tissue into which the straight and oblique muscles of the eyeball were inserted. Removal of this layer of connective tissue and dissection of the ocular muscles revealed the presence of a small, irregularly conical, cartilagenous structure which was apparently the rudiment of the right eyeball. Around its apex was attached the rudimentary retractor muscle. The optic nerve was in the form of a tendonlike structure.

NOSE DEFECTS

The lateral alæ of both nostrils were totally absent, and the medial ones were rudimentary in character, being represented on either side only by an everted semicircular fold of integument having an outline of the pinna of the external ear of man. The left diverticulum nasi was in the form of a shallow oval depression overhung by the anterior end of the rudiment of the medial wing of the nostril. The right diverticulum nasi was about 1.5 centimeters in depth and placed at a higher level than its fellow. On account of the absence of the greater part of the cheeks and incomplete development of the nostrils as well as the walls of the nasal cavity, the anterior half of the septum nasi and the greater part of the tongue were conspicuously exposed. The nasal cavity was in free communication with the oral cavity, the hard palate being totally lacking; it was divided into two unequal parts by the abnormally thick septum nasi which was bent towards the left in its anterior third and had its ventral border projecting freely into the buccal cavity.

SKELETAL DEFECTS

The bones of the skull that presented some interestingly aberrant features were the premaxillæ, maxillæ, palatines, temporal, and mandible. The nasal process of both premaxillæ was totally absent, and their bodies were abnormally thick, forming a ball-like structure which was attached to the anterior extremity of the vomer by their poorly developed palatine processes.

The palatine processes of the maxillæ were likewise completely missing, and the horizontal parts of the palatine bones were very rudimentary and far from each other. The medial surface of each maxilla where the palatine process is supposed to arise was covered with mucous membrane having about fifteen transverse ridges. The soft palate was very incompletely developed, consisting only of two separate musculomembranous folds which were attached to the rudiments of the horizontal parts of the palatine bones. Due to the absence of the palatine processes of the maxillæ and the incomplete development of the horizontal parts of the palatine bones and the soft palate, the entire nasal cavity was in free communication with the mouth. The facial crest of the right maxilla was characterized by a large rounded tuberous anterior end, which apparently accounts for the asymmetry of the face. The left maxilla showed no distinct facial crest, but it was somewhat bulging in the region above the first two premolars; its infraorbital foramen was very small and found just a little below the lower margin of the rim of the orbit. The alveolar border of the left maxilla was much shorter than that of the right.

There was no left temporal fossa, the zygomatic arch and supraorbital process being completely fused dorsally with the walls of the cranium. The mandible was markedly deformed. The perpendicular part of the left ramus was shorter than that of the right, and it presented only a rudimentary coronary process. The anterior parts of both rami were so bent ventrally that the lower jaw did not come in contact with the upper one when the mouth was closed.

MUSCLES AFFECTED

The muscles that were observed to be insufficiently developed were the zygomaticus, orbicularis oris, dilatator naris lateralis, levator labii superioris propious, lateralis nasi, transversus nasi, buccinator, incisivus superior, incisivus inferior, and the left

temporalis. The left and right nasolabiales were undivided and found to be inserted only to the rudiment of the medial wing of the nostrils, blending partly with the zygomaticus.

CONCLUSIONS

With the anatomical data furnished by the specimen it is impossible to determine the causes underlying the origin of its malformations. It seems probable, however, that whatever factor may be responsible in bringing about the anomalies, the changes must have occurred during the early stages of embryonic life. The defects of the cheeks and alæ of the nostrils are undoubtedly due to the failure of the union of the frontonasal and maxillary processes. It seems that there must have been an arrest in the development of the right eyeball after the formation of the optic cup and lens vesicle. Very likely the mesoderm surrounding the optic cup that is destined for the formation of the sclera, chorioid, and cornea failed to undergo differentiation, and the optic cup itself and the lens vesicle became consolidated. The adhesion of the internal surface of the left eyelids to the cornea and of the right ones to the layer of connective tissue may account for the permanent fusion of their edges. The complete absence of the hard palate is apparently due to the failure of the maxillary process to develop a palatine process, which normally consists of a platelike structure that grows across the primary oral cavity towards the median line where it meets and fuses with its fellow from the opposite side and with the lower part of the nasal septum. The anomalies observed in the muscles may be secondary only to the skeletal defects.

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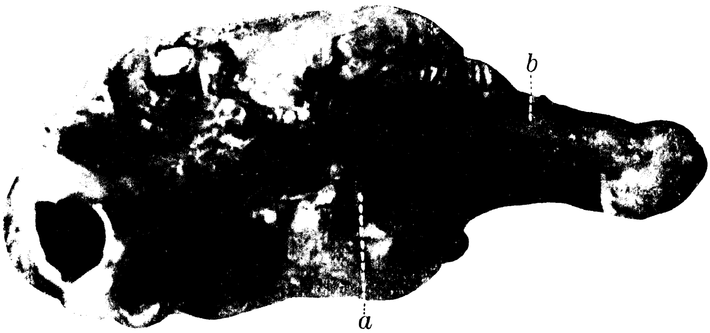
ILLUSTRATION

PLATE 1

FIG. 1. Ventral view of the skull without the mandible; *a*, rudiment of the soft palate; *b*, septum nasi.

2. The young horse two days after birth.



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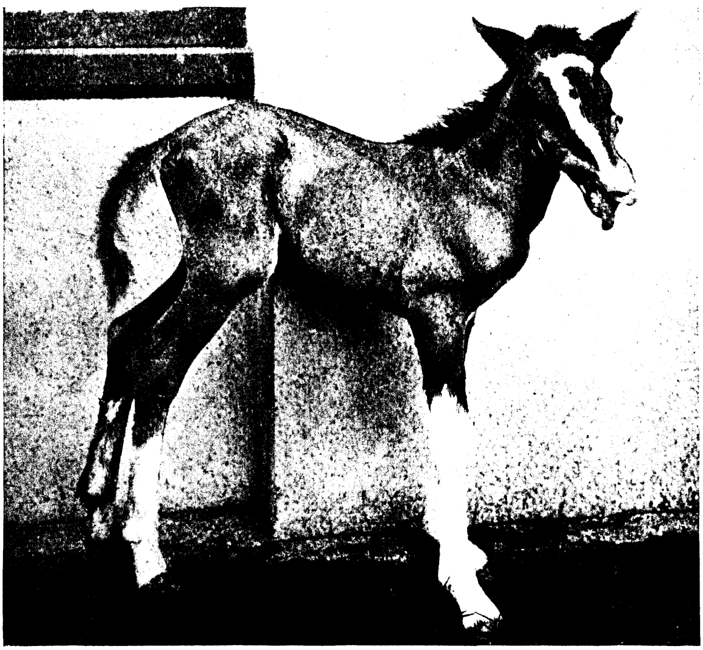

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PLATE 1.

THE EFFECT OF FATIGUE AND EXCITEMENT UPON FORMATION OF IMMUNE BODIES

By H. LARA and P. I. DE JESUS

Of the Department of Hygiene and Preventive Medicine
College of Medicine, University of the Philippines

ONE PLATE AND ONE TEXT FIGURE

INTRODUCTION

Definite knowledge concerning the effect of fatigue and excitement upon artificial immunization is still lacking. The results of investigations that might throw some light upon the present uncertainty regarding the relation of fatigue and excitement to artificial active immunization is, therefore, considered of general interest.

Our paper is a report of a series of experiments designed to determine whether or not a state of acute fatigue and perhaps excitement at the time of inoculation of a bacterial vaccine will cause in experimental animals a diminished or increased production of certain antibodies in the blood stream.

In carefully reviewing the literature we found very meager records on the subject of antibody production in relation to fatigue, no record on the subject of excitement and antibody production, and there is no work so far found on the effect of fatigue and excitement upon vaccine inoculation (artificial immunization).

In 1910 Abbot and Gildersleeve(1) fatigued eighteen rabbits and found that there was always reduction of the opsonic index in so far as it related to infection of pyogenic organisms.

In 1925 Redfield(2) discussed the relation of antibodies and fatigue. He conformed with the generally accepted conception of the effect of fatigue on susceptibility and immunity, but he did not record experimental proofs to substantiate his contention.

In 1921 Oppenheimer and Spaeth,(3) experimenting on seventeen rats, found that fatigue tended slightly to increase their resistance to tetanus toxin and definitely increased their resistance to Type I pneumococcus.

In 1922 Nichols and Spaeth,(4) working on sixteen guinea pigs, found that fatigue increased the resistance of these animals to lethal injections of Type I pneumococcus.

The last two groups of investigators found that fatigue increased the resistance of experimental animals to toxin and infection contrary to the generally accepted belief. So far then, investigations had been made to deal primarily with the relation between fatigue and susceptibility to infection. Our investigation, on the other hand, was made as an attempt to deal with the relation of fatigue and excitement to the production of antibodies resulting from bacterial vaccine inoculation (artificial active immunization).

EXPERIMENTS

In this investigation sixty-two guinea pigs were used. The animals were apparently healthy throughout the experiments, except those that died at the beginning and at the very middle of the period of experimentations before any useful observations could be made on them. No unusual events occurred among the animals that survived, except that two female fatigued pigs gave birth during the period of experimentation. The guinea pigs were fed twice daily with grass and unhusked rice and were allowed to take water ad libitum.

We employed pure typhoid vaccine prepared by us from subcultures obtained from the stock of the Department of Pathology and Bacteriology of the College of Medicine, University of the Philippines. One cubic centimeter of our vaccine contained 1,000 million bacteria. A series of three injections of this vaccine was given subcutaneously to the guinea pigs at intervals of three to seven days. We used a uniform dose of 0.1 cubic centimeter of the vaccine (100 million bacteria) per 100 grams of body weight of the animals. Fatigue and control animals were inoculated at the same time, and the weight of each animal was always taken just before injection.

A week before the first injection of the vaccine, the titer of the serum of each animal against typhoid bacilli was determined macroscopically. One week after the last injection of the vaccine, three successive titrations of each animal's serum against typhoid bacilli were performed by macroscopic method at weekly intervals after the last inoculation of the vaccine. The animals were vaccinated three times. Those belonging to the fatigue group were fatigued first before each vaccination. The administration of the vaccine was always preceded by fatigue and excite-

ment, and the injection was made before the effect of acute fatigue and excitement had subsided.

In the titration of the serum, graded dilutions from 1:20 to 1:800 were prepared and an emulsion of living 24-hour culture of typhoid bacilli of the same strain that was used in making the vaccine was employed. The different mixtures of the emulsion of living organisms and the diluted sera (uniformly shaken) were placed in the incubator for twenty-four hours, after which the agglutination reactions, read macroscopically, were recorded.

We were able to carry out five series of experiments utilizing a total of sixty-two guinea pigs. We attempted always to use an equal number of pigs of the same sex and of approximately the same weight on the control and fatigue groups. The fatigued-excited group included those that were made to run immediately before each injection of vaccine. The control group was neither fatigued nor excited but was injected at the same time as the fatigued-excited group. The same dose of vaccine was given in proportion to the weights of the animals. The same number of injections was administered to each experimental animal, and the removal of the blood as well as the titration were done at practically the same time in every series of control and fatigued-excited groups. In other words, all the animals were subjected to practically the same conditions, with the only difference that one group was fatigued and excited while the other (the control group) was not.

The first batch of animals experimented upon was made up of eight pigs, four in the fatigued-excited group (1 male and 3 females) and four in the control group (1 male and 3 females). In the second batch we used six pigs, three in the fatigued-excited group (1 male and 2 females), and three in the control group (1 male and 2 females). One fatigued-excited male pig died during the experiment and was not included in the final computation of the results. In the third batch, we used twenty-two pigs, eleven in the fatigued-excited group (7 males and 4 females), and eleven in the control group (7 males and 4 females). Four fatigued-excited pigs (3 males and 1 female) died near the beginning of the experiment. Six control pigs (4 males and 2 females) died during the last part of the experiment just before the third titration was made and therefore the observations on the first and second titrations were included. In the fourth batch, we used twelve pigs, six fatigued-excited (3 males and 3 females), and six controls (3 males and 3 females).

In the fifth batch, we used fourteen animals, seven fatigued-excited (4 males and 3 females) and seven controls (4 males and 3 females). One male and one female fatigued-excited animals died at very near the beginning of the experiment before any useful observation could be made on them.

Apparatus.—The apparatus used for fatiguing and exciting the animals consisted of a wire drum 62 by 31 centimeters with a circumference of 1,925 centimeters, made up of half-centimeter square mesh galvanized wire net. It was provided with a handle for turning and a small opening at one side to serve as a door for inserting and withdrawing the animal. The whole drum was mounted on a wooden support. The details of the apparatus are shown in the accompanying illustration.

Methods of fatiguing and exciting the animals.—In fatiguing and exciting the animals the drum was turned by hand. The moving drum served to keep the pigs running. Some pigs learned to run quickly, and others jumped or slid about in a bewildered and helpless manner.

The whole distance covered in running could be computed by multiplying the circumference of the drum by the number of revolutions. However, in our experiment we measured the point of fatigue not in terms of distance or time run but in terms of the effect on the pig and its physical state. For this purpose, we kept the drum moving at the rate of about fourteen revolutions per minute. We determined the fatigue when the pig dropped down fainting and was unable to stand even on stimulation and would rather lie and rest. It took about twenty to thirty minutes to attain our purpose. We took also for granted that in being fatigued the animals were also subjected to considerable excitement. In most cases the fatigue was so pronounced that when the drum stopped moving the animal immediately fell down to its side and was unable to move. It is not improbable, however, that this condition might have been brought about by both fatigue-excitement and vertigo.

EXPERIMENTAL RESULTS

The results of the investigations are presented in Tables 1 and 2 and fig. 1. There are indications that fatigue and excitement and perhaps vertigo had produced a diminished titer in the blood of the fatigue-excited animals, and that while the males were only so slightly affected, the difference in the serum titer between the female control and the female fatigue-excited groups seemed

Table 1.—*Effect of fatigue upon immunity in guinea pigs.*

CONTROL

Batch and animal No.	Sex.	Weight and original titer.	Weight and dose.		
Batch 1:		August 24:	September 20:	September 28:	October 5:
Animal 1	M	550 g —	550 g 0.55 cc	530 g 0.53 cc	520 g 0.52 cc
Animal 2	F	530 g —	560 g 0.56 cc	600 g 0.60 cc	600 g 0.60 cc
Animal 3	F	500 g —	480 g 0.48 cc	500 g 0.50 cc	500 g 0.50 cc
Animal 4	F	350 g —	370 g 0.37 cc	390 g 0.39 cc	410 g 0.41 cc
Batch 2:		October 19:	November 2:	November 7:	November 12:
Animal 5	M	415 g —	430 g 0.43 cc	450 g 0.45 cc	420 g 0.42 cc
Animal 6	F	470 g —	440 g 0.44 cc	420 g 0.42 cc	440 g 0.44 cc
Animal 7	F	790 g —	710 g 0.71 cc	690 g 0.69 cc	700 g 0.70 cc
Batch 3:		November 8:	November 12:	November 15:	November 17:
Animal 8	M	310 g —	320 g 0.32 cc	310 g 0.31 cc	320 g 0.32 cc
Animal 9	M	340 g —	340 g 0.34 cc	330 g 0.33 cc	320 g 0.32 cc
Animal 10	M	400 g —	410 g 0.41 cc	420 g 0.42 cc	390 g 0.39 cc
Animal 11	M	420 g —	420 g 0.42 cc	420 g 0.42 cc	400 g 0.40 cc
Animal 12	F	290 g —	280 g 0.28 cc	260 g 0.26 cc	270 g 0.27 cc
Animal 13	F	300 g —	260 g 0.26 cc	245 g 0.25 cc	230 g 0.23 cc
Animal 14	F	320 g —	320 g 0.32 cc	300 g 0.30 cc	280 g 0.28 cc
Animal 15	F	440 g —	420 g 0.42 cc	460 g 0.46 cc	430 g 0.43 cc
Animal 16	M	480 g —	500 g 0.50 cc	480 g 0.48 cc	460 g 0.46 cc
Animal 17	M	490 g —	450 g 0.45 cc	430 g 0.43 cc	455 g 0.46 cc
Animal 18	M	490 g —	470 g 0.47 cc	450 g 0.45 cc	430 g 0.43 cc
Batch 4:		January 17:	January 25:	January 31:	February 6:
Animal 19	M	590 g —	580 g 0.58 cc	630 g 0.63 cc	570 g 0.57 cc
Animal 20	M	360 g —	350 g 0.35 cc	360 g 0.36 cc	350 g 0.35 cc
Animal 21	M	500 g —	510 g 0.51 cc	500 g 0.50 cc	480 g 0.48 cc
Animal 22	F	400 g —	430 g 0.43 cc	400 g 0.40 cc	380 g 0.38 cc
Animal 23	F	500 g —	505 g 0.51 cc	500 g 0.50 cc	450 g 0.45 cc
Animal 24	F	430 g —	470 g 0.47 cc	430 g 0.43 cc	430 g 0.43 cc
Batch 5:		March 6:	March 22:	March 28:	April 10:
Animal 25	M	720 g	650 g 0.65 cc	610 g 0.61 cc	610 g 0.61 cc
Animal 26	M	720 g	650 g 0.65 cc	630 g 0.63 cc	620 g 0.62 cc
Animal 27	M	530 g	530 g 0.53 cc	510 g 0.51 cc	520 g 0.52 cc
Animal 28	M	650 g	630 g 0.63 cc	580 g 0.58 cc	600 g 0.60 cc
Animal 29	F	350 g	360 g 0.36 cc	370 g 0.37 cc	370 g 0.37 cc
Animal 30	F	490 g	490 g 0.49 cc	500 g 0.50 cc	500 g 0.50 cc
Animal 31	F	470 g	460 g 0.46 cc	460 g 0.46 cc	470 g 0.47 cc

Batch and animal No.	Weight after immunization.	Titer after immunization. 1/20	1/50	1/100	1/150	1/200	1/250	1/300	1/350	1/400	1/500	1/600	1/700	1/800
Batch 1:	October 12													
Animal 1	500 g	+	+	+	+	+	+	+	+	+	—	—	—	—
Animal 2	580 g	+	+	+	—	—	—	—	—	—	—	—	—	—
Animal 3	510 g	+	+	+	+	+	+	+	—	—	—	—	—	—
Animal 4	410 g	+	+	+	+	+	+	+	+	+	—	—	—	—
Batch 2:	November 15													
Animal 5	440 g	+	+	+	+	+	+	+	+	—	—	—	—	—
Animal 6	430 g	+	+	+	+	+	+	+	+	—	—	—	—	—
Animal 7	700 g	+	+	+	+	—	—	—	—	—	—	—	—	—
Batch 3:	November 22													
Animal 8	340 g	+	+	+	+	+	+	+	+	+	+			
Animal 9	340 g	+	+	+	+									
Animal 10	390 g	+	+	+	+	+								
Animal 11	390 g	+	+	+	+	+	+	+						
Animal 12	270 g	+	+	+	+	+	+	+	+	+	+			
Animal 13	230 g	+	+	+	+	+								
Animal 14	320 g	+	+	+	+	+	+	+	+	+	+			
Animal 15	470 g	+	+	+	+	+	+	+	+	+	+			
Animal 16	430 g	+	+	+										
Animal 17	450 g	+	+	+										
Animal 18	410 g	+	+	+	+	+	+	+	+	+	+			
Batch 4:	February 13													
Animal 19	580 g	+	+	+	+	+								
Animal 20	350 g	+	+	+	+	+	+	+	+	+	+			
Animal 21	460 g	+	+	+	+	+	+							
Animal 22	380 g	+	+	+	+	+	+							
Animal 23	450 g	+	+	+	+	+	+	+	+	+	+	+	+	
Animal 24	450 g	+	+	+	+	+								
Batch 5:	April 9													
Animal 25	610 g	+	+	+										
Animal 26	570 g	+	+	+	+	+	+	+						
Animal 27	500 g	+	+	+										
Animal 28	610 g	+	+	+										
Animal 29	380 g	+	+	+	+	+	+	+						
Animal 30	500 g	+												
Animal 31	480 g	+	+	+	+	+	+	+						

Batch and animal No.	Weight after immunization.	Titer after immunization. 1/20	1/50	1/100	1/150	1/200	1/250	1/300	1/350	1/400	1/500	1/600	1/700	1/800
Batch 1:	October 19													
Animal 1	480 g	+	+	+	+	+	+	+	+	—	—	—	—	—
Animal 2	590 g	+	+	+	—	—	—	—	—	—	—	—	—	—
Animal 3	520 g	+	+	+	+	—	—	—	—	—	—	—	—	—
Animal 4	410 g	+	+	+	+	+	+	+	—	—	—	—	—	—
Batch 2:	November 22													
Animal 5	490 g	+	+	+	+	+	+	+	+	+	—	—	—	—
Animal 6	480 g	+	+	+	+	+	+	+	+	+	—	—	—	—
Animal 7	740 g	+	+	+	+	+	—	—	—	—	—	—	—	—
Batch 3:	November 29													
Animal 8	350 g	+	+	+	+	+	+	+	+					
Animal 9	350 g	+	+	+	+	+	+	+	+	+				
Animal 10	320 g	+	+	+	+	+	+	+	+	+				
Animal 11	370 g	+	+	+	+									
Animal 12	230 g	+	+	+	+	+	+	+	+					
Animal 13	270 g	+	+	+	+	+	+	+						
Animal 14	330 g	+	+	+	+	+	+	+	+	+				
Animal 15	430 g	+	+	+	+	+	+							
Animal 16	390 g	+	+	+										
Animal 17	410 g	+	+											
Animal 18	410 g	+	+	+	+	+	+	+	+					
Batch 4:	February 20													
Animal 19	590 g	+	+	+	+									
Animal 20	360 g	+	+	+										
Animal 21	470 g	+	+											
Animal 22	410 g	+												
Animal 23	460 g	+	+	+	+	+	+	+						
Animal 24	470 g	+	+											
Batch 5:	April 16													
Animal 25	550 g	+	+	+	+	+	+							
Animal 26	550 g	+	+	+	+	+								
Animal 27	460 g	+	+											
Animal 28	550 g	+	+	+	+									
Animal 29	370 g	+	+	+	+	+	+							
Animal 30	480 g	+	+											
Animal 31	480 g	+	+	+	+	+	+	+						

Batch and animal No.	Weight after immunization.	Titer after immunization. 1/20	1/50	1/100	1/150	1/200	1/250	1/300	1/350	1/400	1/500	1/600	1/700	1/800
Batch 1:	October 26													
Animal 1	500 g	+	+	+	+	+	+	+	—	—	—	—	—	—
Animal 2	590 g	+	—	—	—	—	—	—	—	—	—	—	—	—
Animal 3	520 g	+	+	—	—	—	—	—	—	—	—	—	—	—
Animal 4	420 g	+	+	+	+	—	—	—	—	—	—	—	—	—
Batch 2:	December 1													
Animal 5	470 g	+	+	+	—	—	—	—	—	—	—	—	—	—
Animal 6	460 g	+	+	+	+	+	+	—	—	—	—	—	—	—
Animal 7	650 g	+	+	+	+	+	—	—	—	—	—	—	—	—
Batch 3:	December 6													
Animal 8	300 g	+	+	+	+	+	+	+	+	+				
Animal 9	310 g	+	+	+	+	+	+							
Animal 10	(a)													
Animal 11	350 g	+	+	+	+									
Animal 12	(a)													
Animal 13	(a)													
Animal 14	300 g	+	+	+	+	+	+	+	+	+				
Animal 15	390 g	+	+	+	+	+								
Animal 16	(a)													
Animal 17	(a)													
Animal 18	(a)													
Batch 4:	February 27													
Animal 19	570 g	+	+											
Animal 20	360 g	+	+	+										
Animal 21	460 g	+	+											
Animal 22	400 g	+	+											
Animal 23	450 g	+	+	+	+	+	+	+						
Animal 24	460 g	+												
Batch 5:	April 23													
Animal 25	560 g	+	+	+	+									
Animal 26	520 g	+	+	+										
Animal 27	460 g	+	+											
Animal 28	600 g	+												
Animal 29	400 g	+	+	+	+									
Animal 30	510 g	+												
Animal 31	490 g	+	+	+	+									

FATIGUED

Batch and animal No.	Sex.	Weight and original titer.	Weight and dose.		
Batch 1:		August 24:	September 20:	September 28:	October 5:
Animal 1	M	480 g	490 g 0.49 cc	490 g 0.49 cc	510 g 0.51 cc
Animal 2	F	620 g	630 g 0.63 cc	650 g 0.65 cc	670 g 0.67 cc
Animal 3	F	410 g	440 g 0.44 cc	450 g 0.45 cc	430 g 0.43 cc
Animal 4	F	435 g	455 g 0.46 cc	470 g 0.47 cc	460 g 0.46 cc
Batch 2:		October 19:	November 2:	November 7:	November 12:
Animal 5	M	610 g	(a)		
Animal 6	F	650 g	470 g 0.47 cc	430 g 0.43 cc	380 g 0.38 cc
Animal 7	F	630 g	560 g 0.56 cc	520 g 0.52 cc	490 g 0.49 cc
Batch 3:		November 8:	November 12:	November 15:	November 17:

Batch and animal No.	Weight after immunization.	Titer after immunization. 1/20	1/50	1/100	1/150	1/200	1/250	1/300	1/350	1/400	1/500	1/600	1/700	1/800
Batch 1:	October 12													
Animal 1	470 g	+	+	+	+	+	+	+						
Animal 2	615 g	+	+	+										
Animal 3	420 g	+	+	+										
Animal 4	450 g	+	+											
Batch 2:	November 15													
Animal 5														
Animal 6	400 g	+	+											
Animal 7	490 g	+	+	+	+									
Batch 3:	November 22													

Batch and animal No.	Weight after immunization.	Titer after immunization. 1/20	1/50	1/100	1/150	1/200	1/250	1/300	1/350	1/400	1/500	1/600	1/700	1/800
Batch 1:	October 19													
Animal 1	450 g	+	+	+	+	+	+	+						
Animal 2	560 g	+	+											
Animal 3	430 g	+												
Animal 4	460 g	+	+											
Batch 2:	November 22													
Animal 5														
Animal 6	430 g	+	+											
Animal 7	550 g	+	+	+	+									
Batch 3:	November 29													

Batch and animal No.	Weight after immunization.	Titer after immunization. 1/20	1/50	1/100	1/150	1/200	1/250	1/300	1/350	1/400	1/500	1/600	1/700	1/800
Batch 1:	October 26													
Animal 1	450 g	+	+	+	+	+								
Animal 2	570 g	+		(b)										
Animal 3	450 g	+												
Animal 4	460 g	+												
Batch 2:	December 1													
Animal 5														
Animal 6	430 g	+	+											
Animal 7	540 g	+	+	+										
Batch 3:	December 6													

Animal	Sex				
8	M	220 g	210 g 0.21 cc	210 g 0.21 cc	200 g 0.20 cc
9	M	280 g	280 g 0.28 cc	270 g 0.27 cc	270 g 0.27 cc
10	M	210 g	210 g 0.21 cc	210 g 0.21 cc	210 g 0.21 cc
11	M	330 g	320 g 0.32 cc	310 g 0.31 cc	310 g 0.31 cc
12	F	270 g	280 g 0.28 cc	260 g 0.26 cc	240 g 0.24 cc
13	F	310 g	310 g 0.31 cc	300 g 0.30 cc	280 g 0.28 cc
14	F	310 g	320 g 0.32 cc	300 g 0.30 cc	300 g 0.30 cc
15	M	(a)			
16	M	(a)			
17	F	(b)			(a)
18	M	(a)			

Animal														
8	220 g	[illegible]												
9	270 g	+	+	+	+	+	+	+	+	+	+			
10	240 g	+	+											
11	320 g	+	+											
12	280 g	+	+	+	+	+	+	+	+					
13	310 g	+	+	+										
14	310 g	+	+											
15														
16														
17														
18														

Animal														
8	[illegible]	[illegible]												
9	300 g	+	+	+	+	+	+	+	+	+	+			
10	240 g	+	+	+										
11	330 g	+	+	+										
12	280 g	+	+	+	+	+	+	+	+	+	+			
13	310 g	+	+	+										
14	310 g	+	+	+	+									
15														
16														
17														
18														

Animal														
8	[illegible]	[illegible]												
9	280 g	+	+	+	+									
10	250 g	+												
11	310 g	+	+	+	+	+	+	+						
12	280 g	+	+	+	+	+	+	+	+	+				
13	300 g	+	+											
14	310 g	+	+											
15														
16														
17														
18														

Batch 4:

Animal	Sex	January 17:	January 25:	January 31:	February 6:
19	M	580 g	580 g 0.58 cc	580 g 0.58 cc	550 g 0.55 cc
20	M	440 g	430 g 0.43 cc	430 g 0.43 cc	420 g 0.42 cc
21	M	520 g	520 g 0.52 cc	500 g 0.50 cc	480 g 0.48 cc
22	F	390 g	390 g 0.39 cc	390 g 0.39 cc	340 g 0.34 cc
23	F	520 g	520 g 0.52 cc	530 g 0.53 cc	500 g 0.50 cc
24	F	420 g	420 g 0.42 cc	410 g 0.41 cc	380 g 0.38 cc

February 13

Animal														
19	550 g	+	+	+	+	+								
20	420 g	+	+	+	+	+								
21	450 g	+	+	+	+									
22	360 g	+	+	+	+	+								
23	510 g	+	+	+	+									
24	400 g	+	+	+	+	+	+							

February 20

Animal														
19	560 g	+	+	+										
20	430 g	+	+	+										
21	450 g	+	+											
22	380 g	+												
23	560 g	+												
24	410 g	+	+											

February 27

Animal														
19	540 g	+												
20	430 g	+	+											
21	440 g	+	+											
22	390 g	+												
23	550 g	+												
24	400 g	+	+											

Batch 5:

Animal	Sex	March 6:	March 22:	March 28:	April 3:
25	M	780 g	700 g 0.70 cc	690 g 0.69 cc	640 g 0.64 cc
26	M	710 g	620 g 0.62 cc	600 g 0.60 cc	540 g 0.54 cc
27	M	(a)			
28	M	700 g	610 g 0.61 cc	590 g 0.59 cc	550 g 0.55 cc
29	F	365 g	370 g 0.37 cc	380 g 0.38 cc	360 g 0.36 cc
30	F	470 g	380 g 0.38 cc	390 g 0.39 cc	350 g 0.35 cc
31	F	(a)			

April 9

Animal														
25	600 g	+	+	+	+	+	+	+						
26	500 g	+												
27														
28	530 g	+	+	+	+	+								
29	340 g	+	+	+										
30	330 g	+												
31														

April 16

Animal														
25	610 g	+	+	+	+	+	+							
26	490 g	+												
27														
28	510 g	+	+											
29	340 g	+	+											
30	330 g	+	+											
31														

April 23

Animal														
25	650 g	+	+	+	+	+								
26	510 g	+												
27														
28	540 g	+												
29	400 g	+												
30	380 g	+												
31														

[a] Died. [b] Delivered two young.

to be quite marked in all three titrations after the last inoculation of the vaccine.

However, one of the most important factors in our experiments, which we failed to consider, much to our regret, was the question of difference in the age distribution of the animals

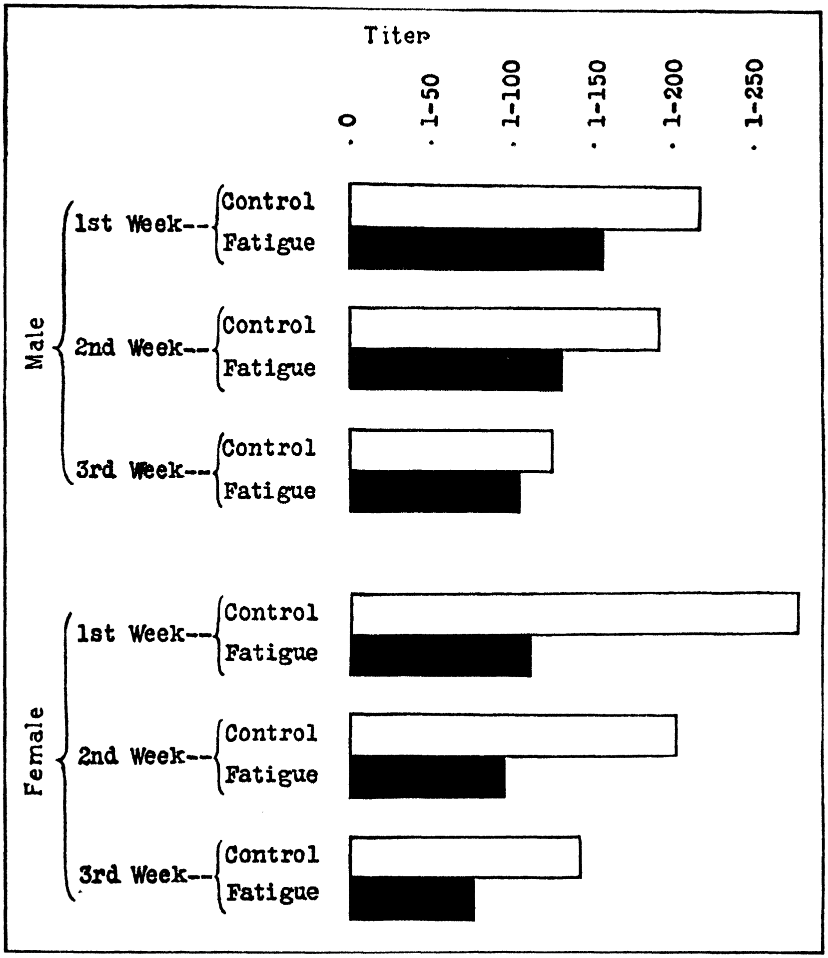

FIG. 1. Effect of fatigue and excitement upon the formation of immune bodies in guinea pigs. (Data from Table 2.)

experimented upon. Besides this, it cannot be denied that the objective method of fatiguing and exciting was to an extent defective. Furthermore, the exhausted condition of the animal after forcing it to run in the experimental drum might have been brought about by factors other than fatigue and excitement.

The disadvantageous choice of experimental animals was also to be regretted because guinea pigs ordinarily would not give high serum titer but the cost of maintenance and availability were certain handicaps that had to be reckoned with.

TABLE 2.—*The effect of fatigue upon immunization in guinea pigs.*

Experimental groups.	Males.					
	Average weight.		Initial titer before inocu-lation.	Mean titer after last inoculation.		
	Before experi-ment.	During experi-ment.		First week.	Second week.	Third week.
	g.	*g.*				
Control	527	488	0	219 ±25	194 ± 22	125± 19
Fatigue	563	451	0	159± 24	132 ±28	105±13
Difference between control and fatigue	36	37	0	60± 35	62 ±35	20 ±23

Experimental groups.	Females.					
	Average weight.		Initial titer before inocu-lation.	Mean titer after last inoculation.		
	Before experi-ment.	During experi-ment.		First week.	Second week.	Third week.
	g.	*g.*				
Control	462	454	0	227±26	203 ± 19	142± 17
Fatigue	457	413	0	112 ±17	96 ±23	76±16
Difference between control and fatigue	5	41	0	165 ±31	107± 30	67 ±21

SUMMARY

1. The literature contains very meager record of work on the subject of antibody production in relation to fatigue and excitement.

2. There is no work found on the effect of fatigue and excitement upon artificial active immunization.

3. An investigation was made, using guinea pigs, to determine the effect of fatigue and excitement on the production of typhoid agglutinins in the blood stream.

4. Judging from our results acute fatigue accompanied by excitement just before the time of inoculation seem to affect unfavorably the production of typhoid agglutinins in the blood stream of female guinea pigs (age distribution not considered) and the males of the species do not seem to be markedly affected.

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ILLUSTRATIONS

PLATE 1. Apparatus used for fatiguing the animals in this experiment.

TEXT FIG. 1. Graph showing the effect of fatigue and excitement upon the formation of immune bodies in guinea pigs. (Data from Table 2.)

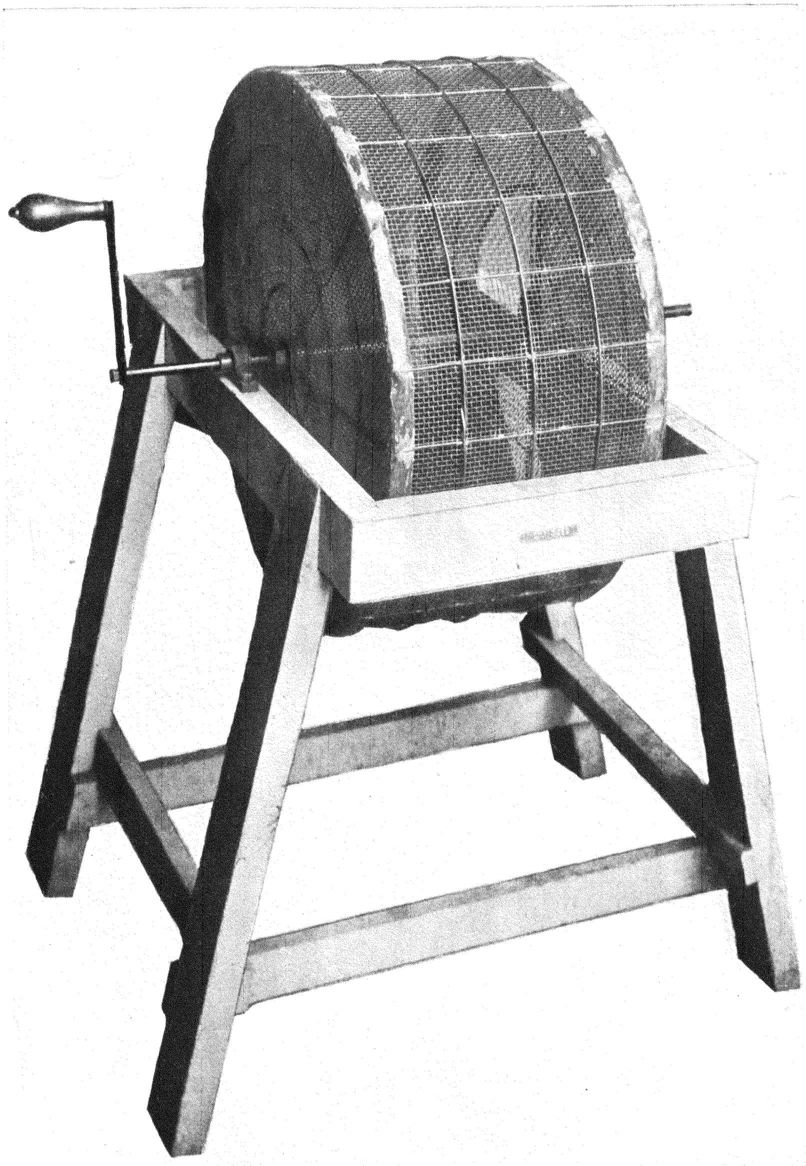

PLATE 1. APPARATUS USED FOR FATIGUING THE ANIMALS IN THIS EXPERIMENT.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), VII [1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

TWO PLATES

The crane flies described herewith are almost all based on extensive collections made in southern Japan and Formosa by my friend Prof. Syuti Issiki, and on Mount Omei, Szechwan, China, by a Canadian collector and secured through Mr. Herbert S. Parish. A few additional Japanese species were collected by Messers. Esaki, Sakaguchi, Ueno, and Uye. The types of the new species are preserved in my collection through the kind generosity of the entomologists above named, to whom my deepest thanks are extended.

As a slight contribution to our knowledge of the Tipulidæ of Japan and Formosa, I am recording in full the species taken by Professor Issiki on Mount Kirishima, in Kiushiu; on Yakushima Island, south of Kiushiu; and on Arisan, a mountain station in Formosa.

TIPULIDÆ FROM MOUNT KIRISHIMA, KIUSHIU

Mount Kirishima, Kiushiu, altitude, 2,500 to 3,500 feet, May 3 to 7, 1929; mostly at 2,500 feet, May 3, 1929 (*Syuti Issiki*).

Limonia (*Limonia*) *machidai* (Alex.).
Limonia (*Dicranomyia*) *basifusca* (Alex.).
Limonia (*Dicranomyia*) *immodestoides* (Alex.).
Limonia (*Dicranomyia*) *punctulata* (de Meij.).
Antocha (*Antocha*) *bifida* Alex.
Tricyphona insulana Alex.
Rhaphidolabis consors Alex.
Dactylolabis longicauda Alex.
Pseudolimnophila horii Alex.
Limnophila (*Tricholimnophila*) *caesiella* Alex.
Limnophila (*Tricholimnophila*) *saitamae* Alex.
Limnophila (*Ephelia*) *dietziana* Alex.
Limnophila (*Prionolabis*) *liponeura* sp. nov.
Limnophila (*Prionolabis*) *submunda* Alex.

[1] Contribution from the Department of Entomology, Massachusetts Agricultural College.

Nippolimnophila kiusiuensis Alex.
Elephantomyia dietziana sp. nov.
Erioptera (*Empeda*) *microtrichiata* Alex.
Erioptera (*Ilisia*) *asymmetrica* Alex.
Ormosia diversipes Alex.
Ormosia tekeuchii Alex.
Molophilus albohalterata Alex.
Molophilus pegasus Alex.

TIPULIDÆ FROM KOSUGIDANI, YAKUSHIMA

Yakushima, an island south of Kiushiu; collections made at Kosugidani, altitude 2,500 feet, in rich native forest, April 29, 1929 (*Syuti Issiki*). Esaki [2] outlines the differences existing between the mountainous, richly wooded island of Yakushima and the indicated presence thereon of Palæarctic forms, and the low-lying nearby Tanegashima Island. The species of the accompanying list are predominantly Palæarctic in affinities and so confirm Esaki's statement.

Limonia (*Discobola*) *margarita* (Alex.).
Limonia (*Limonia*) *anthracina* Alex.
Limonia (*Limonia*) *machidai* (Alex.).
Limonia (*Limonia*) *monacantha* (Alex.).
Limonia (*Limonia*) *tristina* sp. nov.
Limonia (*Limonia*) *yakushimensis* sp. nov.
Limonia (*Dicranomyia*) *paramorio* (Alex.).
Limonia (*Geranomyia*) *radialis* Alex.
Antocha (*Antocha*) *subconfluenta* sp. nov.
Helius (*Helius*) *obliteratus* Alex.
Orimarga yakushimana sp. nov.
Tricyphona yakushimana Alex.
Dicranota (*Amalopina*) *gibbera* (Alex.).
Dactylolabis longicauda megastylata subsp. nov.
Pseudolimnophila horii Alex.
Limnophila (*Prionolabis*) *lipophleps* sp. nov.
Limnophila (*Prionolabis*) *submunda* Alex.
Limnophila subnemoralis Alex., var.
Ulomorpha polytricha Alex.
Nippolimnophila yakushimensis Alex.
Atarba (*Atarbodes*) *minuticornis* sp. nov.
Lipsothrix yakushimae Alex.
Erioptera (*Empeda*) *microtrichiata* Alex.

TIPULIDÆ FROM ARISAN, FORMOSA

Arisan, Formosa, altitude 6,000 to 8,000 feet, July 7 and 8, 1929; mostly at 7,300 feet, July 7, 1929 (*Syuti Issiki*).

Nesopeza trichopyga Alex.
Cyttaromyia taiwania Alex.

[2] Állattani Közlemények 23 (1926) 121.

Limonia (Discobola) argus (Say).
Limonia (Dicranomyia) shirakii (Alex.).
Helius (Helius) liliputanus Alex.
Helius (Helius) rufithorax Alex.
Tricyphona arisana Alex.
Tricyphona formosana Alex.
Adelphomyia ariana Alex.
Ula flavidibasis Alex.
Pseudolimnophila illustris Alex.
Pseudolimnophila marcida Alex.
Limnophila (Tricholimnophila) platystyla parallela subsp. nov.
Limnophila (Dicranophragma) dorsolineata sp. nov.
Limnophila (Dicranophragma) formosa Alex.
Elephantomyia (Elephantomyodes) uniformis Alex.
Elephantomyia (Elephantomyia) luculenta Alex.
Atarba (Atarbodes) fuscicornis Edw.
Atarba (Atarbodes) issikiana sp. nov.
Atarba (Atarbodes) leptoxantha Alex.
Ceratocheilus tinctipennis Alex.
Dasymallomyia signata Brun.
Erioptera (Erioptera) alboguttata Edw.
Erioptera (Ilisia) tenuisentis Alex.
Erioptera (Empeda) angustistigma Alex.
Dasymolophilus nokoensis Alex.
Molophilus aricola sp. nov.
Molophilus nigritarsis Alex.
Molophilus nigritus Alex.

TIPULINÆ

TIPULINI

TIPULA LATILIGULA sp. nov.

General coloration yellowish gray, the præscutum with four scarcely indicated brown stripes; antennæ yellow; wings grayish, the stigma brown; obliterative areas conspicuous; m-cu near the base of cell 1st M_2; male hypopygium with the median region of tergite produced into a compressed blade that is subtended by a small acute spine on either side; eighth sternite bearing a very broad, triangular tonguelike lobe.

Male.—Length, about 11 millimeters; wing, 12.5.

Frontal prolongation of head relatively short and stout, brownish gray; nasus short and stout. Antennæ of moderate length, if bent backward extending abount to the halteres or slightly beyond; the segments yellow, their bases not or scarcely darkened, the outer segments slightly infuscated. Head yellowish gray, the vertical tubercle very low.

Mesonotum yellowish gray, the præscutum with four scarcely indicated brown stripes. Pleura yellowish gray. Halteres pale, the knobs dark brown. Legs with the coxæ yellowish gray,

the trochanters yellow; femora brownish yellow, the tips infuscated; tibiæ and tarsi passing into dark brown. Wings somewhat teneral, grayish, the brown stigma darker; large and conspicuous obliterative areas before the stigma and especially across the base of cell 1st M_2, involving large portions of cells R and M_3; veins dark. Venation: m-cu close to the inner end of cell 1st M_2, M_{3+4} being less than one-half r-m; m-cu very long and oblique.

Abdomen chiefly brownish gray, shrunken and distorted in the type. Male hypopygium (Plate 2, fig. 19) with the tergite extensively fused with the sternite. Ninth tergite (Plate 2, fig. 20) tridentate, the median region produced into a long compressed blade that is slightly upcurved at apex, subtended on either side by an acute spine of less than one-half the length. Outer dististyle, *od*, a large, pale, boomerang-shaped lobe, bearing a tuft of dusky setæ at tip. Ninth sternite, 9*s*, gently emarginate, with a small pencil of about three spinous setæ on either side near the mid-line. Eighth sternite (Plate 2, fig. 21) bearing on caudal margin a very large, broadly triangular, troughlike lobe, the greatest width exceeding the length.

Habitat.—Japan (Honshiu).

Holotype, male, Norikura-ga-take, Shinano, July 22, 1929 (*M. Ueno*).

Tipula latiligula will probably be found to be strictly an alpine species. The structure of the male hypopygium readily separates it from all other regional forms.

LIMONIINÆ

LIMONIINI

LIMONIA (DICRANOMYIA) KANSUENSIS sp. nov.

General coloration opaque brown; rostrum, palpi, and antennæ black; wings strongly tinged with brown; cell 1st M^2 closed; male hypopygium with the rostral prolongation of the ventral dististyle short and stout, bearing two very unequal spines, the inner one very tiny.

Male.—Length, about 6.5 millimeters; wing, 7.3.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval, gradually decreasing in size outwardly. Head yellowish gray.

Mesonotum brown, opaque, without clearly defined stripes; secutellum and postnotum more pruinose. Pleura brown, sparsely pruinose. Halteres pale, the knobs infuscated. Legs with the coxæ pale yellow, the fore coxæ slightly infuscated on

outer face at base; trochanters yellow; remainder of legs yellow, the outer tarsal segments more infuscated. Wings (Plate 1, fig. 1) strongly tinged with brown, the oval stigma still darker brown; scarcely evident darkenings along cord and outer end of cell 1st M_2; veins brown, more yellowish brown basad of the cord. Venation Sc_1 ending just beyond the origin of Rs, Sc_2 a short distance before this origin; cell 1st M_2 closed; m-cu at fork of M; vein 2d A rather strongly sinuous.

Abdomen brown, the ventral dististyle of the hypopygium paler. Male hypopygium (Plate 2, fig. 22) with the lateral lobes of the tergite, *9t*, conspicuous, each with a group of setæ; median region of tergite further produced into a transverse flaplike structure. Ventral dististyle, *vd*, smaller than the basistyle, the rostral prolongation unusually short and stout, bearing at near midlength two very unequal spines, the outermost longest, approximately one-half the length of the prolongation, the inner spine very small. Dorsal dististyle a gently curved blackened rod, the tip acute. Gonapophyses, *g*, with the mesal-apical lobe very long and slender.

Habitat.—China (Kansu).

Holotype, male, Hweihsien (ex Staudinger-Bang Haas).

The structure of the male hypopygium separates this species from all similar forms in this general region.

LIMONIA (LIMONIA) YAKUSHIMENSIS sp. nov.

Mesonotal præscutum and scutal lobes black; remainder of thorax brown; antennæ brownish black throughout, basal segments subglobular; wings strongly suffused with brown; male hypopygium with the dorsal dististyle reduced to a miscroscopic structure; rostral prolongation of ventral dististyle with two distinctly separated spines of approximately equal size.

Male.—Length, about 5.6 millimeters; wing, 6.8.

Rostrum and palpi very much reduced, the former reddish yellow. Antennæ brownish black throughout; basal flagellar segments subglobular, with very short apical necks; outer segments passing into oval, each with a pair of long, unilaterally arranged verticils that are much longer than the segments; outermost segments fusiform, the terminal segment longest, about one-third longer than the penultimate. Head black, subnitidous.

Pronotum blackish. Mesonotal præscutum and scutal lobes black, subnitidous; median region of scutum and the scutellum pale, the surface sparsely pruinose; postnotum pale brown.

Pleura brown, sparsely variegated with darker, the surface more or less pruinose. Halteres of moderate length, pale, the knobs infuscated. Legs with the fore coxæ blackened, pruinose; middle and hind coxæ pale; trochanters obscure yellow; remainder of legs brown, the outer tarsal segments even darker. Wings (Plate 1, fig. 2) with a strong brown suffusion, the oval stigma only slightly darker; linear pale streaks in cell R, crossing cell 1st M_2, and in cell M, crossing m-cu into cell M_4; veins brown. Venation: Sc_1 ending about opposite two-thirds the length of Rs, Sc_2 at its tip; Rs sinuous, nearly straight on basal fourth, the remainder more arcuated; cell 1st M_2 closed; m-cu strongly arcuated, longer than the distal section of Cu_1, placed shortly beyond the fork of M.

Abdominal tergites dark reddish brown, the extreme caudal margins of the segments narrowly blackened; basal sternites more yellowish; male hypopygium pale. Male hypopygium (Plate 2, fig. 23) with the tergite, *9t*, transverse, the caudal margin gently emarginate medially, with a group of long coarse setæ on either side. Basistyle, *b*, with the ventromesal lobe nearly apical in position. Dorsal dististyle reduced to a microscopic structure, as in the group. Ventral dististyle, *vd*, oval, the rostral prolongation elongate, bearing two slender rostral spines that arise from a common tubercle shortly beyond the base of the prolongation.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*).

Limonia yakushimensis is related to *L. fraudulenta* Alexander (Formosa) and *L. ubensis* Alexander (Luzon), differing in the coloration of the body and the structure of the male hypopygium, especially the position and shape of the rostral spines of the ventral dististyle.

LIMONIA (LIMONIA) TRISTINA sp. nov.

Female.—Length, about 9 millimeters; wing, 9.

Closely allied to *L.* (*L.*) *anthracina* Alexander (Japan), differing especially in the uniformly darkened wings and structure of the ovipositor.

Rostrum, palpi, and antennæ black. Head black.

Mesonotum black, the posterior portions of the scutal lobes and the postnotum with piceous reflections. Pleura with the dorsopleural region and the propleura black, the remainder chiefly dark castaneous, the dorsal portion of the sternopleurite

blackened. Halteres pale, the knobs blackened. Legs with the fore coxæ blackened, the middle and posterior coxæ paler; trochanters reddish brown; remainder of legs black, only the femoral bases restrictedly pale. Wings with a strong blackish suffusion, the costal and stigmal regions more suffused; vague, scarcely apparent seams along cord and outer end of cell 1st M_2; a conspicuous clouding along vein Cu_1 in cell M; veins dark brown. Venation: Sc_1 ending before midlength of Rs, Sc_2 at its tip; R_2 about one-half R_{1+2}; m-cu just before the fork of M.

Abdominal tergites black, the sternites yellow, the basal and intermediate sternites with the caudal margins broadly brownish black. Ovipositor with the tergal valves much smaller, slenderer, and more curved than in *anthracina*.

Habitat.—Japan (Kiushiu).

Holotype, female, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*).

LIMONIA (LIMONIA) UNICINCTIFERA sp. nov.

General coloration brown; pleura yellow, striped longitudinally with brown; femora yellow, the tips blackened; remainder of legs snowy white, the tibiæ with a narrow black ring before midlength; wings tinged with yellowish gray, the costal region brighter; cell 1st M_2 closed; abdominal segments annulated yellow and brownish black; male hypopygium with a single rostral spine that arises from a stout tubercle.

Male.—Length, about 7 millimeters; wing, 6.7.

Female.—Length, about 5.5 millimeters; wing, 5.5.

Rostrum gray, the mouth parts and palpi brownish yellow, much reduced in size. Antennæ with the scape dark brown, the flagellum brownish black; flagellar segments oval, passing through elongate-oval; verticils longer than the segments; terminal segment about one-third longer than the penultimate. Head dark brown.

Pronotum yellow. Mesonotal præscutum brown, the lateral margins narrowly obscure yellow; scutal lobes darkened; median region of scutum and the scutellum more pruinose; postnotum slightly pruinose. Pleura yellow with a narrow brown dorsomedian longitudinal stripe; ventral sternopleurite more or less darkened. Halteres dusky, the knobs dark brown. Legs with the coxæ obscure yellow; trochanters brown; femora yellow, the tips conspicuously black; tibiæ pure white with a black ring before midlength, this about one-half as wide as the white basal

portion; tarsi snowy white, including the last segment. Wings (Plate 1, fig. 3) tinged with yellowish gray or brown, the costal region and outer portions of the radial cells clearer yellow; stigma oval, dark brown; narrow and barely evident dark seams along the cord; caudal and posterior regions of wing more infumed, especially in the female; veins brown, Sc more yellow. Venation: Sc_1 ending beyond midlength of the short Rs, Sc_2 at its tip; Rs angulated and weakly spurred close to origin; cell 1st M_2 closed; m-cu close to fork of M; vein 2d A at origin running close to margin, thence approaching vein 1st A.

Abdominal tergites brownish black, narrowly ringed caudally with yellow; sternites yellow, narrowly ringed basally with brown; hypopygium chiefly darkened. Male hypopygium (Plate 2, fig. 24) with the caudal margin of tergite, *9t*, deeply emarginate. Dorsal dististyle a strongly chitinized rod, the apex abruptly narrowed into a gently decurved point. Ventral dististyle, *vd*, fleshy, the rostral prolongation short and stout, at base bearing a large tumid lobe that is larger than the prolongation itself, extended into a single long straight spine. Gonapophyses, *g*, with the mesal apical lobe flattened, pale, terminating in an acute point. Ædeagus, *a*, broad, the apex dilated into two divergent lobes, each lobe with four punctures.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, July 25, 1929 (ex Parish). Allotopotype, female.

Limonia unicinctifera is very distinct from all regional species. In some respects it suggests members of the subgenus *Pseudoglochina*, but it is certainly a true *Limonia*.

HELIUS (HELIUS) COSTOFIMBRIATUS sp. nov.

General coloration brown; legs dark brown, the tips of the tarsi paler; wings with a stronger brown tinge; costal fringe of male long and conspicuous; cell 1st M_2 irregularly pentagonal, m being oblique in position.

Male.—Length, about 7.5 to 8 millimeters; wing, 7.

Female.—Length, about 9.5 to 10 millimeters; wing, 8.

Rostrum a little longer than the head, dark brown; palpi black. Antennæ black throughout, relatively small, a little longer than the rostrum. Head brownish black.

Mesonotum chiefly brown, the præscutum rich cinnamon brown with darker markings; postnotum extensively pale. Pleura brownish yellow, indistinctly variegated with darker. Halteres dirty white, the knobs infuscated. Legs with the coxæ and

trochanters testaceous; femora brown, their bases slightly paler; tibiæ and tarsi dark brown, the tips of the latter paling to brownish yellow. Wings (Plate 1, fig. 4) strongly tinged with brown, the stigmal region darker brown; veins brown. Costal fringe of male long and conspicuous. Venation: Cell 1st M_2 irregularly pentangonal, m being oblique in position and usually longer than the second section of M_{1+2}; m-cu at or close to fork of M.

Abdominal tergites dark brown, the sternites brownish yellow; hypopygium brownish yellow. Male hypopygium much as in *tenuistylus*, the basistyles with a conspicuous spinulose lobe on mesal face at base.

Habitat.—Japan (Loochoo Islands).

Holotype, male, Kunjan, Okinawa, altitude 500 to 1,000 feet, May, 1923 (*S. Sakaguchi*). Allotopotype, female. Paratopotypes, 3 broken males.

Helius costofimbriatus is closely allied to the Formosan *H. tenuistylus* Alexander, differing most evidently in the conspicuous costal fringe of the male.

HELIUS (HELIUS) PALLIDISSIMUS sp. nov.

General coloration pale yellow, including the halteres and most of the legs; head light gray; wings yellow, the veins deeper yellow; cell 1st M_2 rectangular; m-cu close to fork of M.

Female.—Length, about 7.8 to 8 millimeters; wing, 6.6 to 7.

Rostrum of moderate length, a little longer than the combined head and neck, brownish yellow; basal segments of palpi pale, the outer segments brownish black. Antennæ with the scapal segments obscure yellow, the flagellum brownish black; basal flagellar segments short and crowded, the outer segments long and slender; verticils elongate, especially on the outer segments. Head light gray.

Thorax uniformly pale yellow. Halteres pale yellow. Legs with the coxæ and trochanters pale yellow; femora yellow, the remaining segments passing into yellowish brown. Wings (Plate 1, fig. 5) tinged with yellow; veins pale yellow to bright yellow. Venation: Sc_1 ending shortly before fork of Rs, Sc_2 at its tip; anterior branch of Rs relatively short and nearly straight beyond origin, the cell at margin correspondingly widened; cell 1st M_2 large, rectangular; m-cu close to fork of M.

Abdomen reddish yellow, the caudal margins of the segments narrowly paler. Ovipositor with the valves very long and slender, dark horn-yellow.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 4,500 feet, July 28, 1929 (ex Parish). Paratopotype, female, altitude 8,000 feet, July 25, 1929.

In its unusually pale coloration, *Helius pallidissimus* resembles *H. unicolor* (Brunetti), of the Himalayas, differing in the large size and very different venation of the medial field.

ANTOCHA (ANTOCHA) SUBCONFLUENTA sp. nov.

General coloration of mesonotum dark gray, the humeral and lateral portions of the præscutum buffy; wings suffused with gray; cell 1st M_2 tending to be open by the atrophy of m; male hypopygium with the outer dististyle flattened, the outer margin near tip with two or three appressed serrations; ædeagus small.

Male.—Length, about 4.8 millimeters; wing, 5.5.

Rostrum brownish yellow; palpi black. Antennæ black throughout. Head dark gray, the orbits clearer gray.

Mesonotal præscutum almost covered by three confluent dark gray stripes, restricting the ground color to buffy humeral and lateral portions; posterior sclerites of mesonotum dark gray, the scutellum slightly paler. Pleura dark brownish gray, the pteropleurite more reddish brown. Halteres pale, the knobs dusky. Legs with the coxæ reddish brown, the fore coxæ darker; trochanters obscúre brownish yellow; remainder of legs brown, the middle legs and all tarsi somewhat darker. Wings (Plate 1, fig. 6) with a strong gray suffusion, the stigma scarcely indicated; veins pale brown. Anal angle of wing moderately developed. Venation: Cell 1st M_2 open by the partial atrophy of m.

Abdominal tergites brownish black, the basal sternites somewhat brighter; hypopygium obscure yellow. Male hypopygium (Plate 2, fig. 25) with the caudal margin of the tergite, *9t,* transverse to gently concave, with a series of coarse, chiefly marginal setæ. Outer dististyle, *od,* simple, the margin flattened into a blade, with two or three appressed serrations before apex. Gonapophyses, *g,* appearing as slender sinuous yellow rods, the tips acute. Ædeagus, *a,* small.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*).

Antocha subconfluenta is apparently most closely related to *A. confluenta* Alexander (eastern China), differing in the vena-

tion and outline of the wing and in the structure of the male hypopygium.

ORIMARGA CRUCIFORMIS sp. nov.

General coloration plumbeous gray; halteres pale, the knobs infuscated; wings long and narrow, tinted with brown, the apex infuscated, cell R_5 remaining pale; R_2 in approximate alignment with the basal section of R_{4+5} to produce a +-shaped figure; medial forks short; cell 2d A long and narrow.

Female.—Length, about 6.5 millimeters; wing, 5.5 by 1.

Rostrum and palpi black. Antennæ with the basal segment black, the remaining segments dark brown; flagellar segments globular, the outer segments passing into short-oval. Head pruinose.

Thorax blue-gray pruinose, the pleura somewhat clearer gray. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters dark reddish brown; remainder of legs broken. Wings (Plate 1, fig. 7) unusually long and narrow, as shown by the measurements; anal region greatly reduced; membrane pale basally, gradually darkening outwardly, the apex narrowly infuscated, interrupted by the entirely pale cell R_5; veins black. Costal fringe relatively long and conspicuous. Venation: Sc_1 ending just beyond midlength of the long Rs, Sc_2 at its extreme tip; a supernumerary crossvein in cell Sc, opposite origin of Rs; R_2 in approximate alignment with the origin of R_{4+5}, Rs being in alignment with R_3 and R_{2+3} lacking; R_1 and R_{1+2} nearly equal; basal section of R_{4+5} angulated and weakly spurred before midlength; r-m far beyond level of R_2; cell M_3 shallow; m-cu opposite the basal fourth of Rs; cell 2d A long and narrow.

Abdominal tergites brownish black, the sternites somewhat lighter brown. Ovipositor with the tergal valves slender but relatively short.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 6,000 feet, July 25, 1929 (ex Parish).

Orimarga cruciformis is very distinct from all described regional species.

ORIMARGA YAKUSHIMANA sp. nov.

General coloration gray; wings with a faint dusky tinge; veins pale brown; medial field with the outer forks relatively deep.

Male.—Length, about 6 to 6.5 millimeters; wing, 5.6 to 6.2.

Female.—Length, about 6.5 to 7 millimeters; wing, 6 to 6.5.

Rostrum gray; palpi black. Antennæ black throughout; flagellar segments short-oval, the outer segments more elongate. Head gray.

Mesonotum light gray, the median region of the præscutum and the scutal lobes somewhat darker gray. Pleura gray. Halteres pale. Legs with the coxæ dark; trochanters reddish brown; remainder of legs brown. Wings (Plate 1, fig. 8) with a faint dusky tinge; veins pale brown, the outer costal region more yellowish. Macrotrichia almost as in *pruinosa*. Venation: Sc long, Sc_1 ending just before the fork of Rs; free tip of Sc_2 somewhat variable in relation to the position of R_2, the distance from one to two times the total length of the latter; R_{1+2} considerably longer than R_2 alone; forks of medial field much deeper than in *pruinosa*.

Abdomen, including the hypopygium, dark brown.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*). Allotopotype, female. Paratopotypes, 6 males and females.

Orimarga yakushimana is most nearly allied to *O. pruinosa* Alexander (Japan: Honshiu), differing in the larger size, darker wings and veins, and the deep forks of the medial field.

ORIMARGA OMEINA sp. nov.

General coloration dark gray; wings milky white, the veins pale yellowish brown to reddish brown; costal fringe of moderate length only; R_2 lying beyond level of r-m; R_{1+2} variable in length, from two to three times R_2; anal cells large.

Male.—Length, about 6 to 7 millimeters; wing, 5.5 to 6.8.

Female.—Length, about 7 to 7.5 millimeters; wing, 6.5 to 7.5.

Rostrum gray; palpi black. Antennæ with the basal segment of the scape varying from yellow to black, the remaining segments black. Head gray.

Thorax dark gray, without distinct markings. Halteres pale throughout. Legs with the coxæ reddish brown; trochanters brownish yellow; femora yellowish brown; tibiæ and tarsi brownish black to black. Wings (Plate 1, fig. 9) milky white, the veins pale yellowish brown to reddish brown. Costal fringe of moderate length only; no macrotrichia on Rs. Venation: Sc long, Sc_1 ending just before the fork Rs; R_2 far beyond r-m;

R_{1+2} in most cases elongate, approximately three times R_2 alone, in cases shorter, approximately twice R_2; anal cells large.

Abdomen dark brown, more or less pruinose.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 2, 1929 (ex Parish). Allotopotype, female, August 14, 1929. Paratopotypes, several males and females, July and August, 1929.

Orimarga omeina is very close to *O. yakushimana* sp. nov. and may more properly be considered as being only a variety of the latter species, differing especially in the milky-white wings with pale veins, and in slight details of venation. The present species appears to vary to an unusual degree. The two types have the largest measurements given above, in conjunction with an unusually long R_{1+2}.

ORIMARGA SETICOSTA sp. nov.

General coloration brownish gray; thoracic pleura with a narrow black longitudinal stripe; halteres pale throughout; wings yellow, the veins darker yellow; costal fringe long and conspicuous in both sexes; R_2 and r-m in nearly transverse alignment.

Male.—Length, about 5 to 5.5 millimeters; wing, 4.5 to 4.8.

Female.—Length, about 6.5 millimeters; wing, 5.5 to 6.

Rostrum and palpi black. Antennæ with the scapal segments black, the flagellum brown; flagellar segments short-oval, the outer segments becoming slightly more elongate. Anterior part of head buffy, the remainder gray.

Thoracic notum brownish gray to gray, the præscutum with a slightly darker median stripe, the latter in cases weakly bifid; humeral region brighter; posterior sclerites of notum darker, the median area of scutum pale. Pleura brownish gray with a narrow but conspicuous black longitudinal stripe extending from above the fore coxæ to beneath the wing root; ventral sternopleurite narrowly darkened. Halteres pale throughout. Legs with the coxæ and trochanters brownish yellow; femora brownish yellow; remainder of legs gradually passing into brown, the terminal tarsal segments blackened. Wings (Plate 1, fig. 10) relatively broad, especially the anal region, the widest point of wing being at near midlength; ground color pale yellow, the veins darker yellow. Costal fringe of both sexes long and conspicuous. Venation: Sc_1 ending about opposite two-thirds

the length of Rs, Sc_2 at its tip; free tip of Sc_2 faint, a little more than its own length before R_2; Rs relatively long, arcuated; R_{2+3} longer than R_{1+2}; basal section of R_{4+5} angulated before midlength; M_{3+4} subequal to M_4; m-cu about opposite midlength of Rs; anal cells unusually wide, especially cell 2d A.

Abdomen brown, the margins of the segments more blackened; hypopygium brown.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 2, 1929 (ex Parish). Allotopotype, female. Paratopotypes, 5 males and females, July 24 to August 8, 1929.

Orimarga seticosta is readily distinguished by the diagnostic features listed above, especially the long costal fringe in both sexes.

PEDICIINI

DICRANOTA (AMALOPINA) GIBBERA KARAFUTONIS subsp. nov.

Close to the typical form, differing especially in the narrow wings of the male (and undoubtedly both sexes). The wing (Plate 1, fig. 11) is of approximately equal width along the middle third of the width, whereas in the male of typical *gibbera* (Plate 1, fig. 12) the wing is widest opposite the termination of the 2d anal vein, cell 2d A is wider and the auxillary margin is gently incised.

Habitat.—Japan (Karafuto).

Holotype, male, Maoka, July 28, 1922 (*T. Esaki*). Paratopotypes, 6 males; paratype, 1 male, Manui, August 3, 1922 (*T. Esaki*).

Dicranota (*Amalopina*) *gibbera* is closely allied to *D.* (*A.*) *elegantula* (Brunetti), of southeastern Asia. *Amalopina*, together with *Rhaphidolabis* and *Plectromyia*, would seem to be more correctly referable to *Dicranota* as subgeneric groups, although the distinctions existing between several of the so-called genera of pediciine crane flies are very slight. The relation of the narrow-winged males in this and other groups of Tipulidæ to closely allied forms with broad wings in the male is still poorly understood and in the present case, at least, is best expressed by a trinomial until more data become available. Edwards[3] has discussed additional material of *D.* (*A.*) *elegantula* from Assam and Pahang.

[3] Journ. Fed. Malay States Mus. 14 (1928) 127.

HEXATOMINI

DACTYLOLABIS LONGICAUDA MEGASTYLATA subsp. nov.

Male.—Length, about 5 to 6 millimeters; wing, 6 to 7.

General coloration of the head and thorax light blue-gray. Mesonotal præscutum with four narrow dark brown stripes, the intermediate pair not reaching the suture. Legs brownish black. Wings strongly tinged with brown, the transverse elements and certain of the longitudinal veins evidently seamed with brown, to produce a streaked appearance. Venation: Sc_1 ending a short distance before the end of Rs. Abdomen dark gray, the hypopygium dark, including the styli. Male hypopygium with the outer dististyle unusually large, even exceeding in size that of typical *longicauda*, in length about two-thirds that of the basistyle.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*).

LIMNOPHILA (DICRANOPHRAGMA) DORSOLINEATA sp. nov.

General coloration of mesonotum obscure yellow, the region of the lateral præscutal stripes bordered anteriorly by narrow dark brown lines; basal segments of antennæ pale; pleura grayish brown, lined longitudinally with dark brown; femora yellow, more darkened outwardly, the tips abruptly paler; wings strongly suffused with dusky, with a brown pattern that is confined to the vicinity of the veins; wings (male) of approximately equal width throughout their length.

Male.—Length, about 4.6 millimeters; wing, 5.2 to 5.5.

Rostrum and palpi dark brown. Antennæ with the scape and basal two or three flagellar segments yellow, the remainder passing into black. Head gray, the anterior vertex more ocherous.

Mesonotal præscutum with the restricted ground color dark brown, represented by hook-shaped areas surrounding the usual lateral stripes, together with an isolated oval brown spot on lateral portion, sometimes attached to the remaining dark area; scutum and scutellum ocherous brown; postnotum dark brown, pruinose. Pleura grayish brown, with three dark brown longitudinal stripes, the most dorsal lying just below the pale dorsopleural region, extending from the cervical sclerites to the postnotum; second stripe very short, lying between the anepisternum and sternopleurite; third dark area occupying the

ventral sternopleurite. Halteres yellow, the knobs weakly infuscated. Legs with the coxæ brown; trochanters brownish yellow; femora yellow, slightly darkened outwardly, the tips abruptly paler; tibiæ and tarsi obscure yellow, the terminal tarsal segments darkened; legs long, conspicuously setiferous. Wings (Plate 1, fig. 13) strongly suffused with dusky, the dark wash including all of the cells excepting the prearcular and costal regions; dark brown pattern almost as in *formosa.* Wing of approximately equal width throughout the central third of the length. Venation: Vein 2d A ending just before to opposite the level of the origin of Rs.

Abdomen dark brown, the basistyles of the male hypopygium more reddish brown. Male hypopygium (Plate 2, fig. 26) with the inner dististyle, *id,* very stout and broad-based, the apex blunt and fleshy; no conspicuous group of setæ in the axilla of dististyles.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*). Paratopotype, male.

Limnophila dorsolineata is readily distinguished from *L.* (*D.*) *formosa* Alexander (Formosa) by the diagnostic features listed above.

LIMNOPHILA (PRIONOLABIS) LIPOPHLEPS sp. nov.

General coloration gray; antennæ black throughout; halteres yellow; wings tinged with gray, the prearcular region light yellow; cell M_1 lacking; male hypopygium with the inner dististyle bifid at apex; gonapophyses appearing as slender sinuous blackened rods that bear two groups of spines along the outer margin.

Male.—Length, about 5.5 millimeters; wing, 6.5.

Female.—Length, about 5 millimeters; wing, 6.

Rostrum pruinose; palpi black. Antennæ black, the basal segment pruinose; flagellar segments oval, gradually decreasing in size outwardly. Head dark gray, the broad anterior vertex lighter gray.

Mesonotal præscutum black, pruinose with gray; no tuberculate pits; pseudosultural foveæ black. Pleura black, gray pruinose, more heavily so on the sternopleurite. Halteres of moderate length, yellow, the knobs brighter. Legs with the coxæ and trochanters dark, the former pruinose; femora brownish black, their bases obscure yellow; remainder of legs black. Wings (Plate 1, fig. 14) tinged with gray; prearcular

region light yellow; stigma and vague seams along cord and outer end of cell 1st M_2 slightly darker than the ground color; veins pale brown. Marcrotrichia of veins sparse, caudad of the main branch of R being nearly confined to those veins distad of the cord. Venation: Sc_1 extending to opposite the fork of R_{2+3+4}, Sc_2 not far from its tip; R_2 faint, less than R_{1+2}; cell M_1 lacking; m-cu at near midlength of cell 1st M_2.

Abdomen, including the hypopygium, black, pruinose. Male hypopygium (Plate 2, fig. 27) with the caudal margin of the tergite, *9t*, gently notched. Outer dististyle, *od*, gradually narrowed to a slender blackened point, just beyond midlength bearing a small lateral spine. Inner dististyle, *id*, with the apex bifid. Gonapophyses, *g*, entirely blackened, each appearing as a slender sinuous rod that terminates in a long apical spine; on outer margin with two groups of smaller spines, one group being subapical, the other nearer midlength of the apophysis; the number of spines in both these groups variable. Ædeagus, *a*, highly compressed, as in the subgenus.

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*). Allotopotype, female. Paratopotypes, 5 males and females.

The present species and the closely allied *L.* (*P.*) *liponeura* sp. nov. are placed in the subgenus *Prionolabis* with some slight question. The general structure and basic plan of the male hypopygium are the same, but the gonapophyses are rather remarkable in form and depart notably from the otherwise conservative type of the subgenus.

LIMNOPHILA (PRIONOLABIS) LIPONEURA sp. nov.

Male.—Length, about 5.3 millimeters; wing, 6.7.

Female.—Length, about 5.8 millimeters; wing, 6.4.

Closely allied to *L.* (*P.*) *lipophleps* sp. nov., differing especially in the structure of the male hypopygium, notably of the gonapophyses.

Coloration of the body more intensely black. Legs darker-colored, brownish black to black, only the femoral bases restrictedly obscure yellow. Wings darker, slightly broader than in *lipophleps*, the cells being correspondingly widened. Male hypopygium (Plate 2, fig. 28) with the outer dististyle, *od*, broader than in *lipophleps*. Inner dististyle, *id*, with the base more expanded, the terminal tail-like extension simple at apex. Gonapophyses, *g*, of somewhat remarkable form, as figured.

Habitat.—Japan (Kiushiu).

Holotype, male, Mount Kirishima, altitude 3,000 to 3,500 feet, May 4, 1929 (*S. Issiki*). Allotopotype, female, altitude 2,500 feet, May 3, 1929 (*S. Issiki*).

LIMNOPHILA (TRICHOLIMNOPHILA) SATSUMICOLA sp. nov.

Size small (wing not over 6.5 millimeters); general coloration gray; cephalic portion of præscutum not polished; wings brownish yellow, the base brighter, the stigma darker; male hypopygium with the lobes of the tergite relatively long and narrow; not widened distally; outer dististyle and outer arm of the inner dististyle narrow.

Male.—Length, about 4.5 to 5 millimeters; wing, 5.7 to 5.8.

Female.—Length, about 7 millimeters; wing, 6.

Antennæ dark brown, the basal segments a little paler; flagellar segments long-oval. Head gray.

Mesonotum gray, the præscutum with poorly defined brown stripes, the anterior portion not polished black, as in *pilifer*. Pleura gray. Halteres yellow. Legs with the coxæ and trochanters yellow; femora and tibiæ yellow, the tips narrowly infuscated; tarsi brownish black. Wings tinged with brownish yellow, the base brighter yellow, the oval stigma darker; very indistinct seams along cord and outer end of cell 1st M_2; veins dark brown. Macrotrichia of cells confined to those beyond cord, in the allotype greatly reduced in number. Venation: Cell M_1 present, abnormally lacking in one wing of the type; inner ends of cells R_4, R_5, and 1st M_2 in nearly transverse alignment.

Abdomen brownish gray, the hypopygium somewhat brighter. Male hypopygium with the sublateral lobes of the tergite relatively long and narrow, nearly parallel-sided, the tips obtusely rounded, not expanded outwardly as in *caesiella;* emargination separating the lobes subcircular, about twice as wide as the diameter of one lobe. Outer dististyle and outer arm of the inner dististyle both narrow.

Habitat.—Japan (Kiushiu).

Holotype, male, Shiroyama Hill, city of Kagoshima, April 27, 1929 (*S. Issiki*). Allotopotype, female. Paratopotype, male.

Limnophila satsumicola is most closely allied to *L. caesiella* Alexander, differing especially in the size, and in the structure of the male hypopygium, such as the relatively long and slender lobes of the tergite.

LIMNOPHILA (TRICHOLIMNOPHILA) PLATYSTYLA PARALLELA subsp. nov.

Quite as in typical *platystyla* Alexander except for details of structure of the male hypopygium. Median lobe of the tergite

long, parallel-sided, the apex entire, not expanded as in the typical form. Outer arm of the inner dististyle slender, only weakly dilated at tip.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*). Allotopotype, female. Paratopotype, male; paratypes, 2 males, Rantaizan, altitude 4,000 to 6,000 feet, May 20, 1928 (*S. Issiki*).

ATARBA (ATARBODES) ISSIKIANA sp. nov.

General coloration yellow; antennæ pale throughout; mesonotal præscutum yellow, the median stripe bordered anteriorly by a ∩-shaped black mark; each scutal lobe with two black markings; scutellum bordered posteriorly by black; femora yellow, the tips not darkened.

Male.—Length, about 5 to 5.3 millimeters; wing, 6 to 7.

Female.—Length, about 6.5 to 7 millimeters; wing, 7 to 7.5.

Rostrum pale; palpi pale basally, the outer two segments darkened. Antennæ pale throughout, those of the female longer and stouter than those of the male; flagellar segments of male elongate-cylindrical, with long conspicuous verticils; of female with shorter verticils. Head chiefly ocherous yellow.

Mesonotum yellow, the median region of the præscutum bordered anteriorly by a ∪-shaped black mark, each scutal lobe with two brownish black or black marks, the more lateral one largest; scutellum yellow, bordered posteriorly by black, in some cases so extensively as to include almost the whole sclerite; postnotum pale, more infuscated and weakly pruinose behind. Pleura pale yellow. Halteres yellow. Legs yellow, the femoral tips not darkened; terminal tarsal segments infuscated. Wings (Plate 1, fig. 15) yellow, the veins darker yellow. Macrotrichia of veins relatively numerous. Venation: Sc of moderate length, extending about to midlength of Rs, Sc_2 some distance from its tip and shortly beyond origin of Rs; veins issuing from cell 1st M_2 divergent; m-cu beyond the form of M.

Abdomen, including the hypopygium, yellow, the extreme caudal margins of the tergites infuscated; in the female the abdomen is more uniformly darkened.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,300 feet, July 7, 1929 (*S. Issiki*). Allotopotype, female. Paratopotypes, 4 males and females, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*); paratypes, 1 female, Rantaizan, altitude 6,000 to 7,000 feet,

May 21, 1928; 1 female, 7,000 feet, June 2, 1927; 1 female, Sankakuho, altitude 7,000 to 8,000 feet, May 25, 1928 (*S. Issiki*).

A paratype from Rantaizan has the extreme tips of the femora darkened but from the peculiar thoracic pattern would appear to belong here.

The known species of *Atarba* in Japan and Formosa form a group of closely allied forms that are separable chiefly on coloration. It is worthy of note that the antennæ of the female of these species are distinctly longer and stouter than those of the male sex. The described species from this region may be separated as follows:

1. Thoracic dorsum yellow, variegated with black .... 2.
   Thoracic dorsum uniformly yellow .... 4.
2. Femoral tips narrowly blackened .... *A. pallidicornis* Edwards.
   Femoral tips not darkened .... 3.
3. Antennæ dark brown or black throughout .... *A. fuscicornis* Edwards.
   Antennæ pale throughout .... *A. issikiana* sp. nov.
4. General color of the mesonotum polished yellow; wings deep yellow. *A. leptoxantha* Alexander.
   General color of mesonotum opaque testaceous yellow; wings pale yellow. *A. minuticornis* sp. nov.

ATARBA (ATARBODES) MINUTICORNIS sp. nov.

Male.—Length, about 5 millimeters; wing, 5.8.

Closely allied to *A.* (*A.*) *leptoxantha* Alexander (Formosa), differing especially in the shorter antennæ and very pale yellow coloration of the body and wings.

Antennæ (male) small, if bent backward ending some distance before the wing root; flagellar segments elongate-cylindrical, the verticils slightly exceeding the segments. Head and thorax dull testaceous yellow, not nitidous yellow as in *leptoxantha;* vague indications of a darker coloration surrounding the region of the lateral præscutal stripes. Legs broken beyond the trochanters. Wings paler yellow than in *leptoxantha.*

Habitat.—Japan (Kiushiu).

Holotype, male, Kosugidani, Yakushima, altitude 2,500 feet, April 29, 1929 (*S. Issiki*).

ELEPHANTOMYIA (ELEPHANTOMYIA) DIETZIANA sp. nov.

General coloration obscure yellow, the præscutum with a median darkening in front; head gray; halteres pale yellow; pleura more or less darkened; wings tinged with yellow, the oval stigma pale brown; abdominal segments bicolorous, their bases obscure yellow, the apices more broadly blackened; male hypopygium with the gonapophyses beyond midlength spinose.

Male.—Length, excluding rostrum, about 9 to 10 millimeters; wing, 8.2 to 8.5; rostrum, about 7 to 7.5.

Female.—Length, excluding rostrum, about 7.5 to 8 millimeters; wing, 7.5 to 8; rostrum, about 7.

Rostrum black, elongate. Antennæ brown, the scapal segments more pruinose; flagellar segments gradually increasing in length and decreasing in diameter outwardly, with long conspicuous verticils that exceed the segments; terminal segment very small. Head gray, that postgenæ paler.

Pronotum dark brown, obscure yellow laterally. Mesonotum obscure brownish yellow, the præscutum conspicuously darkened medially, this area usually becoming obsolete before the suture; one specimen, a paratype male, has the entire thorax blackened, sparsely pruinose. Pleura more or less dark brownish gray, especially on the sternopleurite, in some specimens more extensive to include almost the entire pleura. Halteres pale yellow. Legs with the coxæ and trochanters yellow; femora yellow basally, passing into brown at tips; tibiæ and tarsi yellowish brown, the latter paler yellow on outer segments. Wings tinged with yellow, the long oval stigma pale brown; veins pale brown, the basal veins more luteous. Venation: Sc_1 ending opposite or just before the fork of Rs, Sc_2 close to its tip; branches of Rs running approximately parallel to one another, cell R_2 at margin being much wider than cell R_3; anterior branch of Rs more or less sinuous beneath the stigma; m-cu at or before midlength of cell 1st M_2.

Abdomen bicolorous, the segments obscure yellow basally, brownish black apically, in the males the dark color becoming more extensive on the outer segments, which are entirely blackened; hypopygium with the basistyles pale. Male hypopygium with the gonapophyses provided with a group of from ten to twelve spines beyond midlength, beyond which point each apophysis is produced into a long pale point.

Habitat.—Japan (Kiushiu).

Holotype, male, Kirishima, altitude 2,500 feet, May 3, 1929 (*S. Issiki*). Allotopotype, female. Paratopotypes, 5 males and females.

Some years ago, Dr. William G. Dietz sent me a brief diagnosis of an *Elephantomyia* preserved in his collection, received from Honshiu, Japan. I believe this represents the present species, and it is fitting to dedicate this distinct species of fly to this distinguished student of the Tipulidæ. The spinous

gonapopyses and marked præscutum separate the fly from the larger and more-northern *E.* (*E.*) *hokkaidensis* Alexander. The somewhat similar *E.* (*E.*) *serotina* Alexander (Formosa) is distinguished by the coloration of the wings and body.

ERIOPTERINI

GONOMYIA (PROGONOMYIA) PERTURBATA sp. nov.

General coloration black, more or less pruinose; pleura black, variegated with obscure yellow; knobs of halteres darkened; legs black; wings tinged with dusky; male hypopygium with three dististyles.

Male.—Length, about 4.5 millimeters; wing, 5.3.

Rostrum dark brown; palpi black. Antennæ black throughout; flagellar segments decreasing in length and diameter outwardly, the verticils exceeding the segments in length. Head black, sparsely dusted with gray.

Mesonotal præscutum black, very sparsely dusted with gray, the anterior lateral pretergites and humeral region restrictedly obscure yellow; scutellum dusky at base, the posterior half light yellow; postnotum dark gray. Pleura black, variegated with obscure yellow, including the suture between the anepisternum and sternopleurite, the meron and adjoining sclerites, and the dorsal portion of the pleurotergite. Halteres dirty white, the knobs infuscated. Legs with the coxæ darkened on outer faces; trochanters brownish yellow; remainder of legs black, the femoral bases scarcely brightened. Wings (Plate 1, fig. 16) with a weak dusky tinge, the stigmal region only restrictedly and vaguely darkened; veins brownish black. Venation: Sc_1 ending just before or opposite the fork of Rs, Sc_2 some distance from its tip, the distance between origin of Rs and Sc_2 about equal to m-cu; cell R_3 deep; m-cu at fork of M.

Abdomen brownish black, including the hypopygium. Male hypopygium (Pate 2, fig. 29) with the outer lateral angle of the basistyle, *b*, produced into a stout setiferous lobe. Three dististyles, *d;* the outermost a glabrous rod that is nearly straight, a little expanded at apex, at base with a conspicuous rounded lobe; second dististyle a broad triangular blade that narrows to an acute apical beak; margin of style with a comb of nine or ten straight yellow pegs; surface of this style with numerous setæ; inner, or third, dististyle bifid at apex into a long spine and a more-flattened blade, the stem with abundant long setæ. Ædeagus, *p*, flattened, terminating in a short curved spine, surface of disk of ædeagus with several long slender setæ.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, July 15, 1929 (ex Parish).

I cannot identify this fly with the Indian *G.* (*P.*) *nigripes* (Brunetti), which has as synonyms *G. nigra* Brunetti, *G. incompleta* Brunetti, and possibly *G. gracilis* Brunetti. It superficially resembles *G.* (*P.*) *alboscutellata* Alexander (Formosa), but the male hypopygium is so different that some of the parts are not readily homologized. It is probable that this species will be found not to be a *Progonomyia* in the strict interpretation of the subgenus.

GONOMYIA (GONOMYIA) OMEIENSIS sp. nov.

General coloration gray; antennæ black throughout; scutellum obscure yellow; pleura yellow, striped longitudinally with bluish gray, most evident on the anterior mesopleura; wings gray, the stigma more brownish; male hypopygium with the inner dististyle a bispinous flattened blade; phallosome asymmetrical, bearing a blackened, spearlike, lateral arm.

Male.—Length, about 4.4 millimeters; wing, 5.

Female.—Length, about 5 millimeters; wing, 5.4.

Rostrum orange; palpi black; in female, rostrum entirely black. Antennæ black throughout, the basal segments of flagellum large, the remainder becoming linear. Head dark gray.

Pronotum fulvous, darker laterally. Anterior lateral pretergites obscure yellow. Mesonotal præscutum brownish gray, the humeral and lateral regions obscure yellow; scutum brownish gray; scutellum obscure yellow; postnotum gray. Pleura pale yellow with two narrow blue-gray longitudinal stripes that are most evident on the anepisternum and ventral sternopleurite, the pteropleurite entirely pale. Halteres relatively elongate, pale, the knobs infuscated. Legs with the coxæ pale, the outer faces of the fore and hind coxæ slightly infuscated; trochanters pale brown; remainder of legs brownish black, passing into black. Wings (Plate 1, fig. 17) gray, the stigma more brownish; veins brownish black. Venation: Sc_1 extending to shortly beyond the origin of Rs, Sc_2 a little removed from its tip; Rs sinuous on basal half; cell 1st M_2 closed; m-cu close to fork of M.

Abdominal tergites dark brown, the sternites paler, the extreme caudal margins of the outer segments narrowly pale. Male hypopygium (Plate 2, fig. 30) with the apex of basistyle, *b*, produced into a small oval setiferous lobe. Outer dististyle,

od, a pale flattened blade that is setiferous on outer margin, the inner margin glabrous. Inner dististyle, *id*, a bispinous flattened blade, the outer spine longest, bearing a single powerful seta near base; smaller spine more curved; apex of style bearing two powerful fasciculate bristles, in addition to about four or five smaller setæ. Phallosome, *p*, asymmetrical, a pale flattened blade, at near midlength bearing a black spear-shaped arm on one side only.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 14, 1929 (ex Parish). Allotopotype, female, August 7, 1929.

Gonomyia omeiensis is allied to *G. affinis* Brunetti (Himalayas), differing in the striped pleura and details of venation. I do not have a male of *affinis* for comparison.

GONOMYIA (LIPOPHLEPS) QUADRIFILA sp. nov.

General coloration brownish gray; head yellow, the center of the vertex with a small dark spot; pleura dark, striped with yellow; femora pale, with a subterminal dark ring; wings dusky, the costal region yellowish white, the disk variegated with pale spots and flecks; Sc short; anterior branch of Rs short and oblique; male hypopygium with three dististyles, two being very long and filiform.

Male.—Length, about 3 millimeters; wing, 3.5.

Rostrum and palpi black. Antennæ with the basal segments obscure yellow, the slender outer segments of the flagellum passing into black. Head light yellow with a small dark spot on the disk of vertex.

Pronotum and anterior lateral pretergites light yellow. Mesonotum brownish gray, the caudal margin of the scutellum a trifle paler; postnotal mediotergite extensively pale, darker posteriorly. Pleura black, pruinose, the pleurotergite pale brownish yellow; a narrow but conspicuous light yellow longitudinal stripe extending from the fore coxæ, passing above the remaining coxæ to the base of the abdomen. Halteres broken. Legs with the coxæ chiefly pale, especially the fore coxæ, the others narrowly darkened at base; trochanters yellowish testaceous; femora brownish yellow, with a narrow dark brown subterminal ring, the extreme tip again narrowly pale; tibiæ and basitarsi yellow, the tips darkened; terminal tarsal segments infuscated. Wings (Plate 1, fig. 18) with a strong brown suffusion, the costal region yellowish white, more extensive before and beyond the stigma; stigma oval, brown; conspicuous grayish

white spots and flecks on the membrane, the most evident appearing as an incomplete crossband before the cord; remaining cells of wing sprinkled with pale; veins dark, the costal veins pale. Venation: Sc short, Sc_1 ending a distance before the origin of Rs about equal to the total length of the latter; anterior branch of Rs unusually short and oblique, the cell at margin being very wide; m-cu at or just before the fork of M.

Abdominal segments brownish black, narrowly ringed caudally with yellow; hypopygium dark. Male hypopygium (Plate 2, fig. 31) with three dististyles, *d*, two very long and filiform; longest style appearing as a very long curved rod that ends in an acute blackened point; second style more than one-half the length of the first, dusky, gently arcuated, the tip obliquely obtuse; third dististyle, or branch, small and fleshy. Phallosome, *p*, large, pale, terminating in two expanded subtriangular dusky blades that lie parallel to one another.

Habitat.—Japan (Kiushiu).

Holotype, male, Yasakagawa, Oita-ken, May 10, 1929 (*T. Uyē*).

Gonomyia quadrifila is most closely related to *G. flavocostalis* Alexander (Japan), differing very conspicuously in the structure of the male hypopygium.

ERIOPTERA (ERIOPTERA) LUTEICORNIS sp. nov.

General coloration pale yellow; palpi black; basal segments of antennæ pale yellow; head pale; pleura yellow with a relatively narrow dusky longitudinal stripe; knobs of halteres blackened; wings pale yellow, the veins yellow, those of the anterior cord slightly infuscated; male hypopygium with the dististyle single but profoundly divided, the two principle arms bearing two unequal black spines in the axil.

Male.—Length, about 3.8 to 4 millimeters; wing, 4.2 to 4.5.

Female.—Length, about 4.5 to 5 millimeters; wing, 5.5 to 6.

Rostrum pale yellow; palpi black. Antennæ with the scape and basal six or seven flagellar segments pale yellow, the outer segments infuscated. Head whitish, the center of the vertex more suffused with yellow.

Pronotum yellowish white, infuscated medially. Mesonotal præscutum light reddish brown, more infuscated medially, the lateral margins paling to yellowish white; pseudosutural foveæ and tuberculate pits reddish brown; scutal lobes light reddish brown; scutellum chiefly pale; postnotal mediotergite reddish brown, more whitish laterally, more darkened behind. Pleura

yellow, with a relatively narrow dusky longitudinal stripe, extending from the fore coxæ to the posterior portion of the postnotum, the pleura dorsad of this stripe very pale, yellowish white, the ventral sclerites somewhat deeper yellow. Halteres pale, the knobs blackened. Legs with the fore coxæ darkened; remaining coxæ and all trochanters yellow; remainder of legs yellow, the outer tarsal segments infuscated. Wings pale yellow, the veins dark yellow; a scarcely evident darkening involving the veins of the anterior cord. Venation: Vein 2d A unusually long and sinuous, at near midlength a little closer to the anal margin.

Abdomen pale brownish yellow, the lateral margins darker, the caudal margins pale. Male hypopygium (Plate 2, fig. 32) with the dististyle, *d*, apparently simple but profoundly branched; outer arm a simple straight rod, the tip acute; inner arm an arcuated flattened blade, provided with marginal setæ; two blackened spines in the axil, one being very small. Gonapophyses, *g*, appearing as flattened pale blades, the acute tips narrowly blackened, the outer margin microscopically roughened.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 4,500 feet, August 14, 1929 (ex Parish). Allotopotype, female. Paratopotypes, 5 males and females, July 31 to August 22, 1929.

Erioptera luteicornis is evidently allied to the Nearctic *E. septemtrionis* Osten Sacken.

ERIOPTERA (ERIOPTERA) HIMALAYÆ sp. nov.

Male.—Length, about 4.5 millimeters; wing, 4.5.

Characters generally as in *E. subtincta* Brunetti, differing especially in the structure of the male hypopygium.

Wings pale yellow, the veins and macrotrichia darker yellow; a faint but distinct clouding on the anterior cord. Venation: Vein 2d A very strongly sinuous, on its distal third extending parallel to the margin or nearly so. Male hypopygium (Plate 2, fig. 33) with the outer dististyle, *od*, a simple flattened rod, gently narrowed and curved to the acute tip, the outer face microscopically roughened. Inner dististyle, *id*, a larger, broadly triangular structure, the outer apical angle produced into a long slender spine, the inner margin microscopically serrulate; inner mesal region of the triangle extended into a dusky flange, weakly and irregularly tridentate on margin. Gonapo-

physes, *g*, appearing as straight slender rods, pale yellow, the dusky tips obtuse.

Habitat.—India.

Holotype, male, Ghumti, Darjiling District, Eastern Himalayas, altitude 4,000 feet, July 1911 (*F. H. Gravely*).

I received this species in exchange with Mr. Brunetti as being *E.* (*E.*) *subtincta* Brunetti and considered the determination as being correct until Edwards [4] published further notes on the type of *subtincta*. From this it is very evident that the present species has nothing in common with *subtincta* nor can I identify it with any of the described regional species. The structure of the male hypopygium is distinctive.

MOLOPHILUS ARICOLA sp. nov.

General coloration brown to reddish brown; antennæ relatively short in both sexes; legs dark brown; halteres yellow; wings yellowish gray, the costal region clearer yellow; abdomen black, the hypopygium reddish brown; lobes of the basistyle not produced into spinous points; surface of inner dististyle glabrous.

Male.—Length, about 3 to 3.2 millimeters; wing, 3.8 to 4.

Female.—Length, about 3.5 to 3.7 millimeters; wing, 4.8 to 5.

Rostrum and palpi black. Antennæ with the scape and basal segments of flagellum yellow, the remaining flagellar segments passing into black; antennæ relatively short, when compared with *pegasus*, with long conspicuous verticils, the outer series longer. Head gray.

Mesonotal præscutum reddish brown to brown, with a faint gray pruinosity; lateral pretergites and narrow lateral margins of the præscutum pale yellow; posterior sclerites of mesonotum more grayish. Pleura dark brown. Halteres pale yellow. Legs with the coxæ and trochanters dark yellow; remainder of legs dark brown, the femoral bases slightly paler. Wings yellowish gray, the prearcular and costal regions clearer yellow; veins darker than the ground color; macrotrichia brown, the costal trichia light golden yellow. Venation: Vein 2d A ending about opposite one-third the length of the petiole of cell M_3.

Abdomen black, the hypopygium conspicuously reddish brown. Male hypopygium with the apical lobes of the basistyle not at all chitinized. Outer dististyle a slender rod, the apex slightly expanded into an oval head that is provided with a few darkened

[4] Rec. Indian Mus. 26 (1924) 300.

tubercles. Inner dististyle glabrous, except for microscopic appressed spinulæ at apex and along outer margin.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 6,500 to 8,000 feet, July 7, 1929 (*S. Issiki*). Allotopotype, female. Paratopotypes, 2 males and females.

Molophilus aricola differs from *M. nigripes* Edwards, which has a somewhat similar hypopygium, by the short antennæ of both sexes. It is even more similar to the Japanese *M. pegasus* Alexander, differing in details of coloration, the shorter antennæ of the male, and slight details of the male hypopygium.

ILLUSTRATIONS

[Legend: *a*, ædeagus; *b*, basistyle; *d*, dististyle; *g*, gonapophysis; *id*, inner dististyle; *od*, outer dististyle; *p*, phallosome; *s*, sternite; *t*, tergite *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Limonia* (*Dicranomyia*) *kansuensis* sp. nov., venation.
2. *Limonia* (*Limonia*) *yakushimensis* sp. nov., venation.
3. *Limonia* (*Limonia*) *unicinctifera* sp. nov., venation.
4. *Helius* (*Helius*) *costofimbriatus* sp. nov., venation.
5. *Helius* (*Helius*) *pallidissimus* sp. nov., venation.
6. *Antocha* (*Antocha*) *subconfluenta* sp. nov., venation.
7. *Orimarga cruciformis* sp. nov., venation.
8. *Orimarga yakushimana* sp. nov., venation.
9. *Orimarga omeina* sp. nov., venation.
10. *Orimarga seticosta* sp. nov., venation.
11. *Dicranota* (*Amalopina*) *gibbera karafutonis* subsp. nov., venation.
12. *Dicranota* (*Amalopina*) *gibbera gibbera* Alexander, venation.
13. *Limnophila* (*Dicranophragma*) *dorsolineata* sp. nov., venation.
14. *Limnophila* (*Prionolabis*) *lipophleps* sp. nov., venation.
15. *Atarba* (*Atarbodes*) *issikiana* sp. nov., venation.
16. *Gonomyia* (*Progonomyia*) *perturbata* sp. nov., venation.
17. *Gonomyia* (*Gonomyia*) *omeiensis* sp. nov., venation.
18. *Gonomyia* (*Lipophleps*) *quadrifila* sp. nov., venation.

PLATE 2

FIG. 19. *Tipula latiligula* sp. nov., male hypopygium, lateral view.
20. *Tipula latiligula* sp. nov., male hypopygium, ninth tergite.
21. *Tipula latiligula* sp. nov., male hypopygium, eighth sternite.
22. *Limonia* (*Dicranomyia*) *kansuensis* sp. nov., male hypopygium.
23. *Limonia* (*Limonia*) *yakushimensis* sp. nov., male hypopygium.
24. *Limonia* (*Limonia*) *unicinctifera* sp. nov., male hypopygium.
25. *Antocha* (*Antocha*) *subconfluenta* sp. nov., male hypopygium.
26. *Limnophila* (*Dicranophragma*) *dorsolineata* sp. nov., male hypopygium.
27. *Limnophila* (*Prionolabis*) *lipophleps* sp. nov., male hypopygium.
28. *Limnophila* (*Prionolabis*) *liponeura* sp. nov., male hypopygium.
29. *Gonomyia* (*Progonomyia*) *perturbata* sp. nov., male hypopygium.
30. *Gonomyia* (*Gonomyia*) *omeiensis* sp. nov., male hypopygium.
31. *Gonomyia* (*Lipophleps*) *quadrifila* sp. nov., male hypopygium.
32. *Erioptera* (*Erioptera*) *luteicornis* sp. nov., male hypopygium.
33. *Erioptera* (*Erioptera*) *himalayæ* sp. nov., male hypopygium.

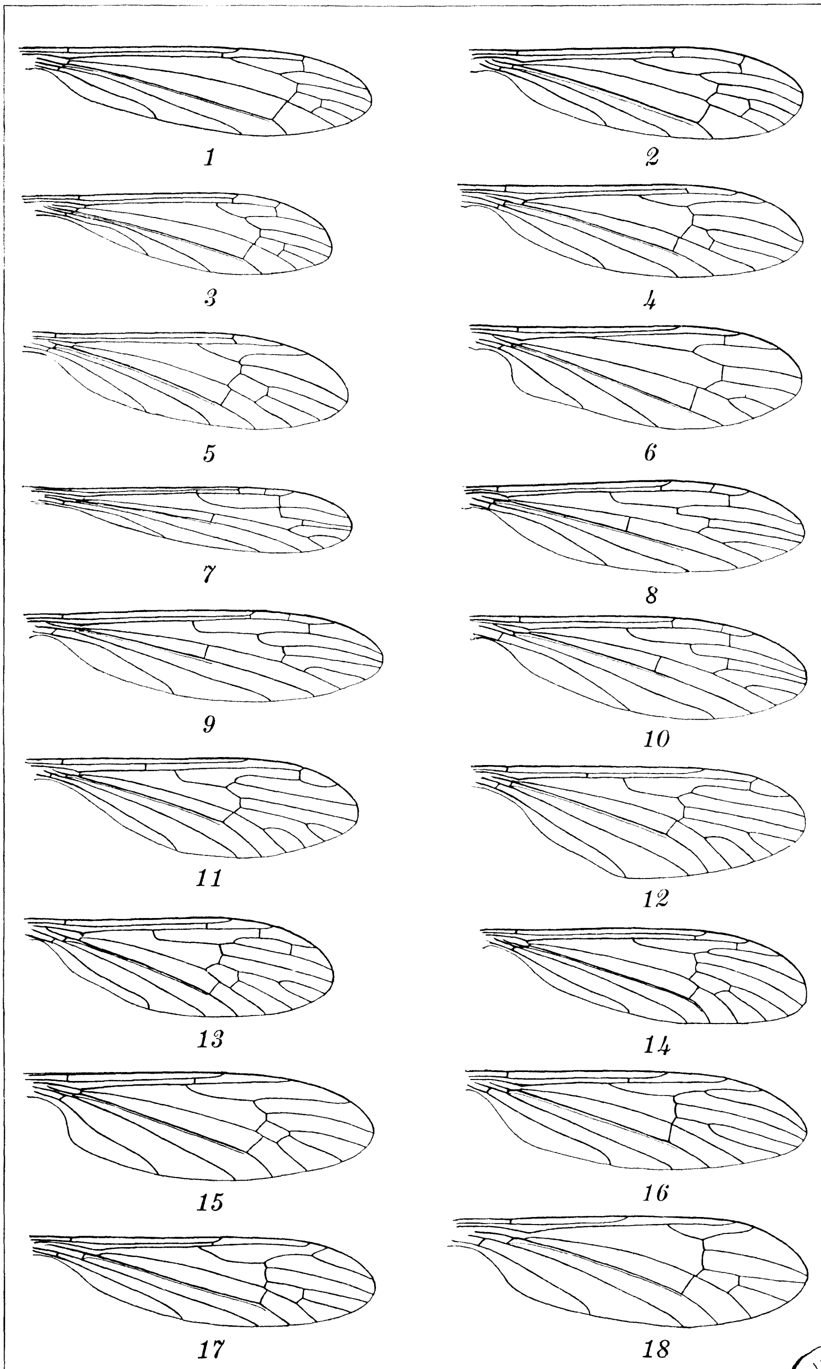

PLATE 1.

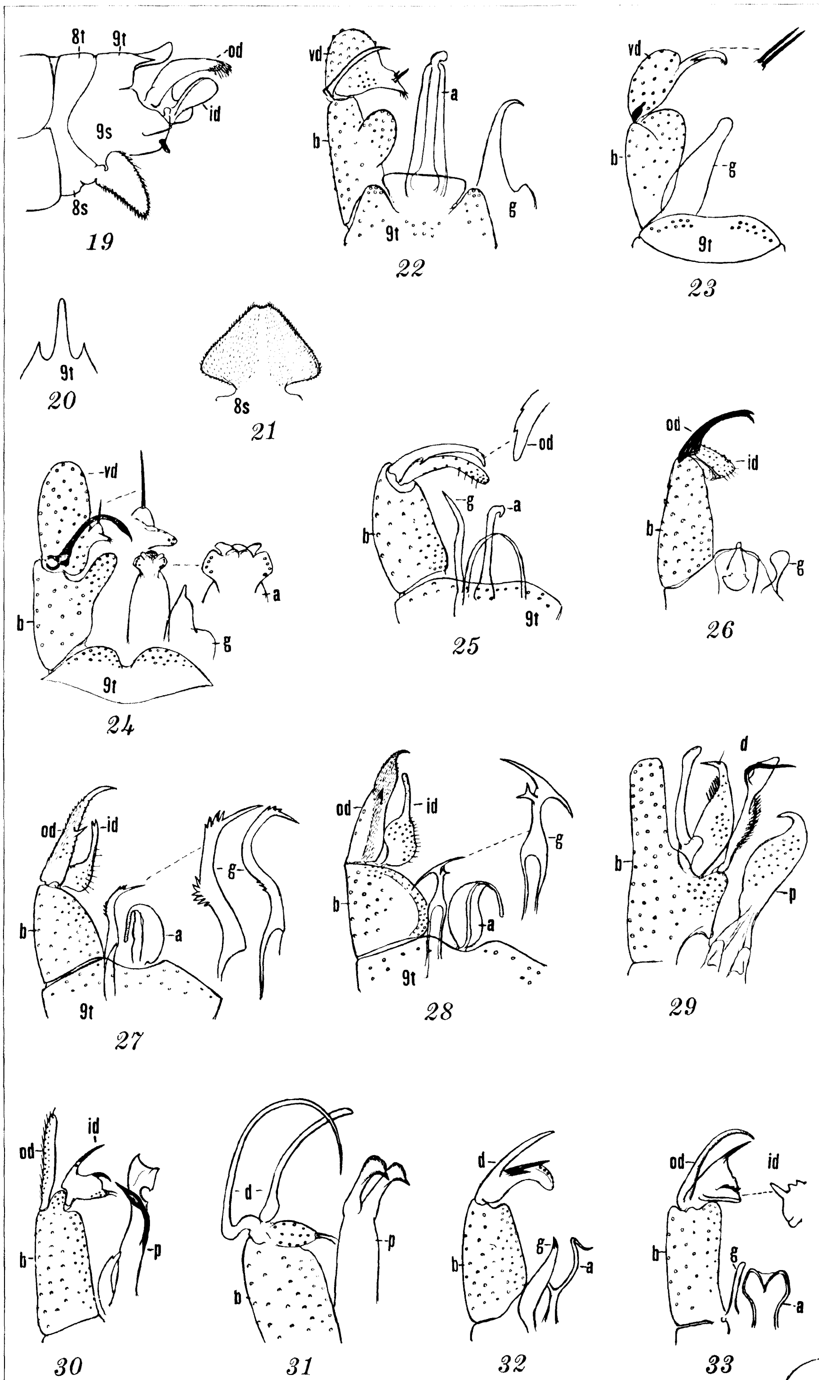
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PLATE 2.

PHILIPPINE ERICACEÆ, II: THE SPECIES OF VACCINIUM

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SEVEN PLATES

HISTORY

It is a rather curious fact that Blanco, author of the Flora de Filipinas (1837), ed. 2 (1845), knew no Philippine ericaceous plants; but Blanco had almost no material from medium and higher altitudes where these plants thrive.

Specimens representing *Vaccinium* were first collected in the Philippine Islands by Cuming. Between October, 1836, and November, 1839,[1] he collected four species; none of these was described before 1886. Jagor, in 1861, collected a species which remained unnamed until 1905, when it was described by Warburg as *Vaccinium jagori.* Sebastian Vidal secured two species from Mount Banahao in 1870 or shortly thereafter, both of which were included, characteristically in error, in Father Fernandez-Villar's Novissima Appendix to Blanco's Flora (1880), under the name of *Vaccinium microphyllum* Reinwardt. Vidal mentioned species of *Vaccinium* without positive identification in works published in 1883 and 1885; in 1886, in his Revision de las Plantas Vasculares Filipinas, based on his own collections, he described six species; namely, *V. barandanum, V. indutum, V. cumingianum, V. benguetense, V. luzoniense,* and *V. villarii.* Two species collected by Cuming were here identified, respectively, as *V. cumingianum* and *V. villarii.* All of these names, except the last, have proved valid. The last name, *V. villarii,* was applied to one of the species included under *V. microphyllum* Reinwardt by Fernandez-Villar, for whom Vidal named it; Vidal himself had previously, in 1883, suggested that this collection might represent *V. varingiaefolium* (Blume) Miquel. It was not until 1917 that Merrill reduced *V. villarii* to *V. myrtoides* (Blume) Miquel.

[1] Merrill, E. D., Philip. Journ. Sci. 30 (1926) 153–185.

Whitehead collected one species on Mount Halcon, Mindoro, in 1895; this was described by Rendle in the following year as *V. mindorense,* but was reduced by Merrill, in 1908, to *V. microphyllum* Reinwardt. Warburg, in 1886, recollected one of Cuming's unnamed species. Perkins's Fragmenta Florae Philippinae, based on material in European herbaria and published in 1905, represents for the Ericaceæ, at least, the final clean-up of material collected before the American occupation of the Islands; Dr. O. Warburg considered the Ericaceæ, and described *Vaccinium caudatum,* which had been collected by Cuming and by himself; *V. philippinense,* the remaining species of Cuming's collection; and *V. jagori.*

Dr. E. D. Merrill, who has advised me in this work, described *V. apoanum* in 1905. This species had been collected by Copeland, Williams, and others, on Mount Apo and elsewhere; it has since been transferred by Schlechter (1918) to the genus *Dimorphanthera.* In 1906 Merrill added *V. banksii.* In November of that year he ascended Mount Halcon, Mindoro, as a member of an expedition organized by General Leonard Wood, and brought back eight species; these were included in a flora of Mount Halcon which was published in the Philippine Journal of Science in 1907. Only two of these eight species, namely *V. halconense* and *V. whitfordii,* received at that time names which can now be maintained; two others, *V. hutchinsonii* and *V. pyriforme,* are here reduced to the rank of varieties; *V. villarii* and *V. mindorense,* as already mentioned, are synonyms of other species; the collection cited as *V. banksii* represents a species that is here described as new; and the material that was identified in the following year with a new species, *V. tenuipes,* was not by itself adequate for description. In 1908 Merrill described *V. lanaense;* I consider this species to represent a new generic type and hence exclude it from *Vaccinium.* Later in the same year Merrill published a revision of the Philippine Ericaceæ, including the new *V. tenuipes, V. palawanense,* and *V. vidalii* (R. A. Rolfe, of Kew, shares the authorship of the last) : the number of species had now risen to nineteen. In 1909 *V. alvarezii* Merrill was added.

In 1911 Elmer published his important contribution on the Ericaceæ of Mount Apo. Ten species of *Vaccinium* are listed; these include, however, the misnamed *V. villarii, V. apoanum* Merrill, which is a *Dimorphanthera,* and also *V. calelanum,* a synonym of *Dimorphanthera apoanum* (Merrill) Schlechter;

V. medinilloides, described as new, but actually a synonym of *V. lanaense,* which, as noted above, is not a true *Vaccinium;* and *V. mearnsii,* which I here construe as a synonym of *V. sylvaticum,* published in the same place. There remain as valid new species of *Vaccinium,* as I now understand the several forms, only *V. elegans, V. perrigidum,* and *V. sylvaticum;* and as correctly named old ones, *V. microphyllum* and *V. palawanense.* In 1912 Elmer added *V. gitingense.* Merrill in the same year added *V. camiguinense, V. epiphyticum,* and *V. loheri;* the last, however, is not a *Vaccinium,* but is congeneric with *V. lanaense,* discussed above. In 1915 Merrill published *V. turbinatum* and *V. macgregorii,* which I consider to be synonyms of *V. alvarezii* and *V. indutum,* respectively. Elmer in the same year published *V. agusanense.* In 1917 Merrill added *V. platyphyllum* and *V. angustilimbum;* and in 1919, *V. ilocanum.* I am reducing *V. angustilimbum* to *V. jagon,* and *V. ilocanum* to *V. platyphyllum.*

Much of the nomenclatorial confusion apparent in the above history was cleared up in Merrill's Enumeration of Philippine Flowering Plants, of which the fascicle including the Ericaceæ appeared in 1923. One new name under *Vaccinium,* namely *V. costeroides,* appears in this work; it comes in by the transfer of *Diplycosia lucida* Merrill (non *V. lucidum* Miquel). This species is here excluded from *Vaccinium,* being congeneric with *Vaccinium lanaense.* Thirty-six species of *Vaccinium* were admitted in Merrill's Enumeration; a single species, *V. rizalense* Merrill, has been published between 1923 and the present, and this I reduce to *V. platyphyllum.*

Twenty-six previously described species are here maintained, and three new ones are described, making a total of twenty-nine species. As to the remainder of the species in Merrill's Enumeration, five are reduced to synonymy, and two to the rank of varieties (beside these, five new varieties are described); while three species are excluded from the genus, as representing a new generic type as yet unnamed.

In studying this group, I have had the use of the Philippine and Indo-Malaysian specimens of *Vaccinium* in the herbarium of the Bureau of Science at Manila; the United States National Herbarium; the herbarium of the University of California; and the Dudley Herbarium, of Stanford University. These herbaria are designated respectively by the letters M, W, C, and S, in the citations of specimens below. The Bureau of Science material is unusually complete, bearing the original field notes.

For assembling this abundant material, for supplying numerous suggestions, and for supervising my work, I owe the fullest acknowledgments to Doctor Merrill.

DISTRIBUTION AND HABIT

I would arrange the Philippine forms of *Vaccinium*, according to their habitat, in three categories; namely, plants of comparatively low elevations, plants of the mossy forest, and plants of the summit chaparral.

Forms occurring at elevations notably below 1,000 meters include *V. gitingense, V. caudatum, V. vidalii,* some varieties of *V. cumingianum, V. suluense, V. platyphyllum, V. tenuipes, V. irigaense,* and *V. alvarezii.* Among these, *V. tenuipes* is a scandent plant, distributed from Luzon to Negros, and so variable that I suppose it may eventually be necessary to segregate several species or varieties from it. *Vaccinium platyphyllum* and V. *alvarezii* are sometimes epiphytic, and have notably large leaves.

Vaccinium vidalii is known only from Luzon. The type specimen bears a field note stating that the plant shows the "balete" habit. *Balete* is the Tagolog vernacular name for strangling figs; these plants, starting as epiphytes, later become connected with the ground by stemlike roots, and ultimately assume the form of shrubs or trees. This habit is ascribed to a *Vaccinium* in connection only with the single specimen here mentioned; one may speculate as to its occurrence in many of the species which have been collected sometimes as shrubs and sometimes as epiphytes.

The remainder of the low-altitude species are terrestrial shrubs or trees. *Vaccinium caudatum* is one of the most widely distributed species, extending from Luzon to Mindanao; this species is perhaps not to be distinguished from *V. hasseltii* Miquel, the type of which was from Java. *Vaccinium suluense,* occurring on Mindanao, Sulu, and Balambangan Island, near the northeast corner of Borneo, is one of three Philippine species that are definitely known not to be strictly endemic.

Most of the species occur at elevations of 1,000 meters or more, and of these the majority are shrubs or trees; they are, therefore, among the larger plants of the mossy forest. Forms which occur, either consistently or occasionally, as epiphytes in the mossy forest, include *V. agusanense, V. epiphyticum, V. barandanum* var. *hutchinsonii, V. perrigidum, V. alvarezii, V. halconense, V. palawanense, V. sylvaticum, V. tenuipes, V.*

cumingianum var. *pyriforme, V. whitfordii,* and *V. microphyllum.* With the exception of the last four, these epiphytes are among the species with larger leaves; this character may have something to do with the epiphytic habit. Of the four exceptional species, *V. tenuipes* has been discussed already; the other three occur at extreme elevations, and share the characters of the shrubs of summit chaparral.

Some of the shrubs and epiphytes in the mossy forest are rather widely distributed; *V. halconense* is about as widely distributed as *V. caudatum,* and *V. palawanense* is known from both Palawan and Mindanao. A larger number of species are of strictly limited distribution. Some of these, as *V. jagori, V. cumingianum, V. barandanum, V. benguetense,* and *V. philippinense,* are well known through the thorough exploration of the regions in which they occur. *Vaccinium epiphyticum, V. camiguinense, V. elegans,* and *V. woodianum,* on the other hand, which come from less-explored regions, are known by only one collection each; *V. sylvaticum* is known by only two collections.

Stunted shrubs disposed to form a chaparral on mountain peaks include *V. foxworthyi, V. myrtoides, V. banksii, V. woodianum,* and *V. whitfordii.* All of these are notably small-leaved species; this character is almost certainly an adaptation to the environment. *Vaccinium myrtoides* and *V. whitfordii* are among the most widely distributed species, and the former extends outside of the Philippine Islands; *V. woodianum* is known by only one collection, and *V. banksii* and *V. foxworthyi* by only two each.

Judging by the number of species known only by one or two collections, we may confidently expect the discovery of more as exploration proceeds.

The third species that extends beyond the Philippine Islands, beside *V. suluense* and *V. myrtoides,* is *V. microphyllum.*

None of the species here mentioned is known to be economic importance; none is in cultivation. Wiegand, in Bailey's Standard Cyclopedia of Horticulture, mentions *V. erythrinum* Hooker as in cultivation under glass in Europe; this is a Javan species of the same group, generally not regarded as distinct from *V. varingiaefolium* (Blume) Miquel.

CLASSIFICATION

The type species of the genus *Vaccinium* is *V. myrtillus* Linnæus; this and the not distantly related *V. vitis-idaea* Linnæus are shrubs occurring in the northern parts of Europe, Asia, and

America. The very numerous other species are widely distributed in the northern hemisphere; a few of them occur south of the equator. A few furnish edible berries, or are of reputed medicinal use; this is a minor source of interest in the group. The large number of species has led to several attempts to arrange them in natural subgeneric groups, and to the more or less doubtful segregation of several other genera; the classifications proposed, however, leave one in doubt of their naturalness. No attempt is here made to solve the problem of the phylogeny of the genus as a whole.

The Philippine *Vaccinia* with the exception of *V. microphyllum*, and likewise the majority of the *Vaccinia* of Borneo, Java, Sumatra, and the Malay Peninsula, have the fruits spuriously ten-celled, with several seeds forming a column in each cell: they are further characterized by prominent disks above the insertion of the perianth, and by pubescent filaments.

For species ancestral to these, we look naturally to India, and examine first a group called the subgenus *Epigynium*, based on a genus of that name described by Klotzsch;[2] this being the group to which most authors have ascribed the species now under discussion. The type of this group is the Indian *V. serratum* Wight; in assigning several Javan species to the same genus, Klotzsch listed them among "species non satis notae." *Vaccinium serratum* and its closest allies, *V. leschenaultii*, *V. neilgherrense*, and *V. donianum*, are all figured by Wight, the author of these combinations,[3] as having five-celled ovaries with many ovules; the fruits, however, as I have found in all specimens bearing these names, include only five seeds, and are so portrayed by Hooker.[4] We can scarcely suppose that this group, in which the number of developing ovules is reduced, is ancestral to one in which it is not; rather we must suppose that *Epigynium* proper is collaterally related to the Malayan vacciniums.

The same may be said of the genera *Agapetes* and *Pentapterygium*, whose close relationship to *Epigynium* proper calls into question the action of Bentham and Hooker, Drude, and other authors, in assigning them to a typically South American tribe; likewise of *V. dunalianum*, *V. petelotii*, and *V. longibracteatum*, with entire leaves and five-celled ovaries; and of *V. malacense*

[2] Linnaea 24 (1851) 49.

[3] Ic. Pl. Ind. Or. 4 (1850) tt. 1180–1194.

[4] Bot. Mag. (1859) t. 5105; *Epigynium leucobotrys* Nutt. ex Hook. = *V. serratum* Wight, fide Ind. Kew.

Wight, with serrate leaves, a ten-celled fruit with many seeds, and anthers with tubes but without horns.

The groups here named are all closely related, and the subgenus *Epigynium* may be maintained as including all of them; or better, all except *Agapetes* and *Pentapterygium*, these being small natural groups with definite distinctive characters. Meanwhile, although I am unable confidently to name any species or group as ancestral to the typical Malayan *Vaccinia*, I suppose that the latter constitute a natural group to be separated from the others, and especially from *Epigynium* proper, as a section. I propose to call this group the section *Nesococcus*.

The classification of this group has presented great difficulty. This difficulty is closely associated with my inability to recognize the species or group which is immediately ancestral to, or most primitive within, the section under consideration. I have divided the Philippine species into eight apparently natural subsections, which may be distinguished by description; the distinctions between these subsections, however, break down when one attempts to include the extra-Philippine species. It appears that there have been changes, within several distinct lines of descent, in the presence of horns and tubes on the anthers; in the pubescence of corolla, disk, style, ovary, and calyx lobes; in the presence and nature of the bracts; and in the relative bulk of disk and ovary. It follows that these characters cannot be used with confidence in the diagnosis of natural groups. I am inclined to the opinion that most of the changes have been reductions; it would follow that the most primitive species are those with anthers bearing conspicuous horns and tubes, whose flower parts are generally pubescent, and whose racemes bear conspicuous bracts. I lack the thorough knowledge of the vacciniums of neighboring lands which would enable me to test these ideas in detail.

As my subsections are but vaguely recognizable, I have not thought it expedient to name them.

Nesococcus does not include all the vacciniums of the Malay Islands. Among Bornean species excluded are *V. acuminatissimum* Miquel,[5] *V. elliptifolium* Merrill, and *V. cordifolium* Stapf. In describing the last species, Stapf pointed out a relationship to

[5] Hooker's genus *Rigiolepis* would include *Gaylussacia lanceolata* Blume = *V. acuminatissimum*, supposedly the only species in the genus. If the specialized ovary justifies generic distinction, Blume's specific name should replace Miquel's and Hooker's.

V. cereum Forster, a Polynesian species which either by itself or with from two to half a dozen segregates makes up the section *Macropelma*. *Vaccinium cordifolium* is, I believe, even closer to, and truly a member of, the characteristic group of New Guinea, whose members have entire leaves, flowers in bractless racemes, strictly five-celled ovaries, prominent calyx lobes, and anthers whose tubes open by a longitudinal slit instead of a terminal pore. This is the group which Schlechter very inappropriately called *Euepigynium*.[6] *Vaccinium cordifolium,* with prominent horns on the anthers, may perhaps be regarded as the most primitive species of the group; this species is perhaps derived immediately but independently from the same ancestors as *Nesococcus*.

From the New Guinean group just discussed, we may perhaps derive Schlechter's section *Oarianthe*.[7] The members of this group have axillary flowers and five-celled ovaries, the calyx limb forming a crateriform tube for some distance above its insertion on the ovary, the stamens generally with very short tubes and no horns. To *Oarianthe,* a group with many species in New Guinea, I assign *V. microphyllum,* which occurs in the Moluccas, Celebes, and the Philippines.

NATURAL ARRANGEMENT OF THE PHILIPPINE SPECIES OF VACCINIUM

Key to the sections and subsections.

1. Ovary spuriously 10-celled; filaments pubescent; flowers usually in racemes, sometimes solitary........ Section *Nesococcus*.
  2. Disk as bulky as the ovary or more so.
    3. Leaves large, 5 to 10 cm long; anthers with horns and tubes; racemes with a large bract subtending each pedicel. Subsection 1.
    3. Leaves smaller or, if leaves large, anthers without horns; bracts variable, not as above except in one species of Subsection 5.
      4. Tubes of the anthers attenuate, decidedly longer than the rest of the anther; no horns........ Subsection 4.
      4. Tubes of the anthers not as above.
        5. Leaves without glands all along the margins or, if these are present, anthers with definite tubes.
          6. Anthers less than 2.5 mm long, with or without horns and tubes........ Subsection 5.
          6. Anthers at least 3 mm long, without horns; leaves large (5 to 10 cm long); flowers large (about 1 cm long). Subsection 3.

[6] Engler's Bot. Jahrb. 55 (1918) 174.

[7] T. c. 169.

5. Leaves with glands all along the margins; anthers without horns and tubes .... Subsection 7.
2. Disk less bulky than the ovary.
3. Anthers with long straight tubes, horns rudimentary or none; leaves mostly large (5 to 10 cm long); raceme with a large foliaceous bract subtending each pedicel; disk pubescent or not. Subsection 2.
3. Anthers without long tubes, with or without horns; bracts variable, not as above; disk pubescent.
4. Anthers with horns except in *V. cumingianum*, which may be distinguished from Subsection 8 by the characters given for the latter .... Subsection 6.
4. Anthers without horns; leaves small, tough, ovate rather than elliptic or lanceolate, with one or two basal marginal glands. Subsection 8.
1. Ovary 5-celled; filaments glabrous; flowers axillary.... Section *Oarianthe*.

Keys to the species of the subsections of Nesococcus, and of section Oarianthe.

SUBSECTION 1

1. Bracts of the inflorescence about 1.5 cm long, persistent; Luzon. 1. *V. philippinense*.
1. Bracts of the inflorescence about 0.5 cm long, deciduous; Mindanao. 2. *V. agusanense*.

SUBSECTION 2

1. Leaves decidedly more than 5 cm long.
2. Ovary densely white-pubescent........ 3. *V. indutum*.
2. Ovary with a sparse, apparently glandular, pubescence.
3. Style pubescent........ 4. *V. epiphyticum*.
3. Style glabrous........ 5. *V. barandanum*.
1. Leaves less than 3 cm long........ 6. *V. gitingense*.

SUBSECTION 3

1. Calyx lobes ciliate; corolla urceolate; Mindanao........ 7. *V. perrigidum*.
1. Calyx lobes glabrous; corolla barrel-shaped; Luzon........ 8. *V. alvarezii*.

SUBSECTION 4

1. Plants from low elevations throughout the Philippines; venation obscure. 9. *V. caudatum*.
1. Plants from elevations of 1,000 meters or more in northern Luzon; venation obvious........ 10. *V. benguetense*.

SUBSECTION 5

1. Anthers with definite horns; trees with ovate leaves 4 to 7 cm long, in Mindanao and Sulu .... 11. *V. suluense*.
1. Anthers with rudimentary horns; trees with elliptic or lanceolate leaves 5 cm long, in Mindanao .... 12. *V. elegans*.
1. Anthers with no horns; northern species.

2. Leaves ovate or lanceolate, acuminate; racemes with simple or glandular pubescence.
   3. Branchlets and rachises with a capitate-glandular pubescence; bracts not as in *V. platyphyllum.*
      4. Terrestrial plants; leaves 5 to 7 cm long; racemes longer than the leaves; filaments flattened, nearly glabrous. 13. *V. luzoniense.*
      4. Usually scandent; leaves 3 to 5 cm long; racemes shorter than leaves; filaments bulbous and densely pubescent at the base. 14. *V. tenuipes.*
   3. Branchlets and rachises simply pubescent; racemes with a bract 1 cm long subtending each pedicel; leaves often over 10 cm long; a rare species, often epiphytic........................ 15. *V. platyphyllum.*
2. Leaves obovate, acuminate; glabrous shrubs with leaves about 5 cm long, from southern Luzon .... 16. *V. irigaense.*

SUBSECTION 6

1. Anthers with horns.
   2. Leaves obovate, large, very obtuse; petiole flattened, as broad as long; inflorescence glabrous; Mindanao........................ 17. *V. camiguinense.*
   2. Leaves and petioles not as above.
      3. Leaves 6 to 9 cm long; ovaries densely pubescent; plants often epiphytic .... 18. *V. halconense.*
      3. Leaves less than 5 cm long; or if the leaves are larger, ovaries glabrous or very nearly so.
         4. Ovary pubescent; shrubs from summit chaparral on Palawan. 19. *V. foxworthyi.*
         4. Ovary glabrous.
            5. Leaves elliptic, very variable in size, with one or two marginal glands at the base; style pubescent........ 20. *V. palawanense.*
            5. Leaves lanceolate, acuminate, about 3 cm long, with glands all along the margins; style glabrous.................... 21. *V. vidalii.*
1. Anthers without horns; leaves mostly less than 5 cm long, variable in shape and margin; plants otherwise resembling *V. vidalii.* 22. *V. cumingianum.*

SUBSECTION 7

1. Flowers in racemes.
   2. Disk and ovary pubescent.
      3. Leaves 5 to 10 cm long; plants of Mindanao, often epiphytes. 23. *V. sylvaticum.*
      3. Leaves less than 5 cm long; chaparral shrubs of Negros. 24. *V. banksii.*
   2. Ovary glabrous.
      3. Disk pubescent; chaparral shrubs of Mindoro...... 25. *V. woodianum.*
      3. Disk glabrous; mossy forest shrubs of Luzon................ 26. *V. jagori.*
1. Flowers solitary in the axils of leaves; leaves about 1 cm long. 27. *V. whitfordii.*

SUBSECTION 8

A single species .... 28. *V. myrtoides.*

SECTION OARIANTHE

A single species .... 29. *V. microphyllum.*

Artificial key to the species.

1. Flowers in racemes.
   2. Racemes with a conspicuous foliaceous bract subtending each pedicel.
      3. Leaves decidedly over 5 cm long.
         4. Ovary densely pubescent; corolla pubescent; anthers without horns.
            5. Corolla urceolate, less than 1 cm long; anthers with short tubes; pedicels about 0.5 cm long .... 15. *V. platyphyllum.*
            5. Corolla tubular to campanulate, more than 1 cm long; anthers with long tubes; pedicels about 1 cm long .... 3. *V. indutum.*
         4. Ovary glabrous or nearly so; corolla glabrous.
            5. Corolla less than 1 cm long; anthers with horns.
               6. Bracts of the inflorescence about 1.5 cm long, persistent; Luzon .... 1. *V. philippinense.*
               6. Bracts of the inflorescence about 0.5 cm long, deciduous; Mindanao .... 2. *V. agusanense.*
            5. Corolla more than 1 cm long; anthers with long tubes but no horns.
               6. Style pubescent .... 4. *V. epiphyticum.*
               6. Style glabrous .... 5. *V. barandanum.*
      3. Leaves less than 3 cm long.
         4. Leaves crenulate; pedicels more than 1 cm long, longer than the flowers .... 6. *V. gitingense.*
         4. Leaves entire; pedicels 1 cm long or less, not longer than the flowers .... 28. *V. myrtoides.*
   2. Bracts absent from the racemes or obscure and occasional.
      3. Ovary densely pubescent.
         4. Leaves ovate or lanceolate, acuminate, 3 to 5 cm long; branchlets and rachises glandular-pubescent .... 14. *V. tenuipes.*
         4. Leaves usually elliptic; branchlets and rachises not glandular-pubescent.
            5. Leaves decidedly less than 5 cm long.
               6. Anthers not horned; leaves with glands all along the margins. 24. *V. banksii.*
               6. Anthers horned; leaves with one or two marginal glands at the base .... 19. *V. foxworthyi.*
            5. Leaves 5 cm long or more.
               6. Anthers horned; leaves with one or two marginal glands at the base; rachis of the raceme pubescent. 18. *V. halconense.*
               6. Anthers not horned; leaves with glands all along the margins; rachis of the raceme glabrous .... 23. *V. sylvaticum.*
      3. Ovary glabrous or very slightly pubescent.
         4. Branchlets and rachises glandular-pubescent.
            5. Terrestrial plants; leaves 5 to 7 cm long; racemes longer than the leaves; filaments flattened, nearly glabrous. 13. *V. luzoniense.*
            5. Usually scandent; leaves 3 to 5 cm long; racemes shorter than the leaves; filaments bulbous and densely pubescent at the base .... 14. *V. tenuipes.*
         4. Herbage not glandular-pubescent.

5. Leaves obovate, rounded at the apex, 3.5 to 8 cm long, punctate beneath, with one or two marginal glands at the base; petiole about 3 mm long, flattened, as wide as long; stamens unknown.. 17. *V. camiguinense.*
5. Leaves not as above.
  6. Anthers without horns, split for much more than half their length into attenuate tubes; disk about as bulky as the ovary, glabrous.
    7. Plants from low elevations throughout the Philippines; venation obscure.. 9. *V. caudatum.*
    7. Plants from elevations of 1,000 meters or more in northern Luzon; venation obvious...................... 10. *V. benguetense.*
  6. Anthers without tubes as above, with obvious horns.
    7. Leaves ovate, usually slightly acuminate, 4 to 7 cm long. 11. *V. suluense.*
    7. Leaves elliptic, apex and base acute, very variable in size. 20. *V. palawanense.*
    7. Leaves lanceolate, acuminate, about 3 cm long. 21. *V. vidalii.*
    7. Leaves lanceolate, acuminate, about 10 cm long. 2. *V. agusanense.*
  6. Anthers without tubes as above, horns obscure or absent.
    7. Disk pubescent; leaves generally less than 5 cm long.
      8. Leaves oval, ovate, or broadly elliptic; chaparral shrubs.
        9. Leaves with one or two marginal glands at the base. 28. *V. myrtoides.*
        9. Leaf margins glandular, crenulate, especially toward the apex.. 25. *V. woodianum.*
      8. Leaves lanceolate or narrowly elliptic.
        9. Disk as bulky as the ovary; tree of Mindanao. 12. *V. elegans.*
        9. Disk less bulky than the ovary; shrub or small tree of the northern islands.............. 22. *V. cumingianum.*
    7. Disk glabrous; leaves generally more than 5 cm long.
      8. Anthers less than 2 mm long.
        9. Leaves obovate or oblanceolate, acuminate, with a petiole about 2 mm long and 1 mm wide. 16. *V. irigaense.*
        9. Leaves elliptic, usually acute, the petiole about 3 mm long, equally wide.................................... 26. *V. jagori.*
      8. Anthers bulky, about 3 mm long; leaves petioled, broad and leathery, of very variable shape.
        9. Calyx lobes ciliate; corolla urceolate; Mindanao. 7. *V. perrigidum.*
        9. Calyx lobes glabrous; corolla barrel-shaped: Luzon. 8. *V. alvarezii.*

1. Flowers solitary in the axils of leaves; leaves less than 2 cm long.
  2. Leaves obovate or oblanceolate, crenulate.................. 27. *V. whitfordii.*
  2. Leaves ovate, entire.. 29. *V. microphyllum.*

Subgenus EPIGYNIUM (Klotzsch) Drude

Epigynium KLOTZSCH in Linnaea 24 (1851) 49.

Vaccinium sectio *Epigynium* BENTH. and Hook. f. Gen. Pl. 2 (1876) 574.

Vaccinium subgenus *Epigynium* DRUDE in Engler and Prantl Naturl. Pflanzenfam. 4 (1891) 52.

Sectio NESOCOCCUS sectio nova

Vaccinium sectio *Epigynium a, c,* et in parte *b,* BENTH. and HOOK. f. Gen. Pl. 2 (1876) 575.

Arbores vel frutices, terrestres vel epiphytici; foliis mutabilissimis saepius integris. Flores saepius inter minores, racemosi, rarissime solitarii, saepe bracteati, bracteis magnis vel parvis; ovarium spurie 10-loculatum, cellulis pluriovulatis, in fructu plurispermis, disco prominente; filamenta pubescentia; antherae mutabilissimae, dorse biaristatae vel muticae, apice tubulosae vel truncatae, dehiscentia antherarum per poros rimosve breves apicales, nunquam per rimos tubulis aequilongis. Incolant peninsulam Malayanam, insulasque Malayanas et Philippinas. Typus est *Vaccinium philippinense* Warburg.

I would prefer to have designated as the type one of the Javan species, but lack confidence in the identifications of the specimens available to me and in the validity of the names.

SUBSECTION 1. ALLIES OF VACCINIUM PHILIPPINENSE

Shrubs or trees, mostly terrestrial; leaves large, acute or acuminate; anthers with horns and tubes; disk glabrous, about as bulky as the ovary or more so.

Miquel gave to certain Javan plants the names *Vaccinium teysmanni, V. laurifolium, V. floribundum,* and *V. ellipticum.* The distribution of these species, and the distinctions between them, are not well known; while some authors have applied other specific names, either in describing new species or in replacing names preoccupied, Koorders [8] reduced all to *V. teysmanni* and *V. laurifolium.* Whatever treatment of these Javan species may be correct, related to them are *V. sarawakense* Merrill, of Borneo; *V. philippinense* and *V. agusanense,* of the Philippines; and probably *V. latissimum* J. J. Smith, of Celebes, and *V. appendiculatum* Schlechter, of New Guinea.

These plants vary considerably among themselves, in the presence of glands and hairs on the leaves, and likewise on the

[8] Exkursionsflora von Java 3 (1912) 13, 18.

rachises of the racemes, the pedicels, and the ovaries; in the presence, size, and persistence of bracts on the racemes; and in the length and stoutness of the pedicels. The Philippine species have prominent bracts on the racemes, and glabrous ovaries.

1. **VACCINIUM PHILIPPINENSE Warburg.**

Vaccinium philippinense WARBURG in Perk. Fragm. Fl. Philip. (1905) 174; MERR., in Philip. Journ. Sci. 3 (1908) Bot. 377, Enum. Philip. Fl. Pl. 3 (1923) 251.

Vaccinium sp. VIDAL, Phan. Cum. Philip. (1885) 22, 123.

The original description reads:

Frutex glaber, ramis tetetibus cinereis striatis minute lenticellatis; ramulis striatis angulatis, petiolis 5—7 mm longis canaliculatis in sicco griseis; foliis glabris ellipticis vel ovato-ellipticis basi acutis apice longe et oblique abrupte acuminatis acutis 5—8 cm longis, 2½—3¼ cm latis, pergamaceis, integerrimis margine revolutis, supra nitidis, subtus pallidoribus in sicco fuscescentibus, quintuplinerviis, venis 2—3 utrinque ascendentibus, nervis tertiariis utrinque distincte prominulis reticulatis. Racemis axillaribus folia subaequantibus vel paullo longioribus glabris multifloris; bracteis persistentibus late lanceolatis acutis glabris, 1—1½ cm longis, 3—5 mm latis; floribus in pedicellis crassis 6—8 mm longis saepe nutantibus, calyce hemisphaerico 3 mm lato apice breviter 5 dentato, dentibus latis brevissime acuminatis; corolla late campanulata fere globosa 5 mm in diametro, ore angusto, lobis 5 recurvatis obtusis; filamentis brevibus dense lanatis, antheris linearibus pendulis basi saccatis apice in tubulos breves productis, subtus ad filamenti apicem subulate biappendiculatis; stylo columnari apice subincrassato; bacca globosa infra apicem calyce coronata, in sicco nigro.

Philippine Isl. (CUMING no. 832).

Philippine Islands (Luzon, Tayabas Province, ex Cuming's list in herb. Kew, fide Merill) *Cuming 832* (M, cotype) : Luzon, Laguna Province, Mount Maquiling, *Reyes* (M), *Holman* (M, S), *Merrill 8035* (M), *Baker 374* (M), *For. Bur. 24897 Mabesa* (M, W), *Elmer 17938* (M, W, C, S), *Elmer 18308* (M, C) ; San Antonio (Paete), *Bur. Sci. 15057 Ramos* (M, W) : Rizal Province, Mount Susong-dalaga, *Bur. Sci. 29359 Ramos and Edaño* (M, W) ; Montalban, *Loher 12482, 13252, 13265* (M, C) ; San Isidro, *Philip. Pl. 303 Ramos* (M, W) ; Angilog, *Loher 6185, 6191, 6195* (M) ; Mount Irig, *Bur. Sci. 42288 Ramos* (M) ; Mount Lumutan, *Bur. Sci. 29769 Ramos and Edaño* (M) ; Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26408 Ramos and Edaño* (M, W).

A terrestrial plant, 2 to 5 meters high. The original description is in error in stating that the racemes are glabrous; the rachises and pedicels are sparsely puberulent. The ovary is

glabrous, the acuminate calyx lobes ciliate; the glabrous disk is about as bulky as the ovary. The leaves bear, all along the margins, minute glands at intervals of a few millimeters. On the bracts these glands are somewhat more prominent. The surfaces of the leaves are totally glabrous, but the lower surfaces are wrinkled by the abundant veins.

This species is apparently confined to central Luzon; the collections are numerous because of the thorough exploration of Mount Maquiling. On that mountain this species is found at altitudes of about 1,000 meters; that is, in the mossy forest near the summit; elsewhere it has been found at lower altitudes.

2. **VACCINIUM AGUSANENSE Elmer.**

Vaccinium agusanense ELMER in Leafl. Philip. Bot. 7 (1915) 2630; MERR., Enum. Philip. Fl. Pl. 3 (1923) 247.

Fruticulus epiphyticus; foliis herbaceis, lanceolatis, acuminatis, margine minute distante glandulosis, 3- ad 5-plinerviis, reticulatis, c. 10 cm longis, petiolis c. 1 cm longis. Racemi c. 10 cm longi, fugace bracteati, pedicellis c. 1 cm longis, rhachidibus, bracteis, pedicellis, bracteolis, ovariisque puberulentibus. Ovarium haemisphericum, c. 2 mm latum, quam disco glabro minus, lobis 5 calycis ciliatis, minute acuminatis. Corolla urceolata, c. 5 mm longa, parce puberulens, lobis 5 minutis reflexis. Stamina c. 3 mm longa, filamentis basi aplanatis, barbatis; antheris c. 1.5 mm longis, ad medio in tubulos duos divisos, dorso bicornutis, cornibus tubulis subaequantibus. Stylus glaber. Fructus ignotus.

The original description reads:

An epiphytic shrub; stems few, widely scattering, crooked, only sparingly rebranched, 2 cm thick and terete at the base; wood tough and hard, dingy white; bark smooth, light gray on the stem, deep brown on the branchlets; young twigs reddish brown when dry and glabrous. Leaves conduplicate, copious, alternate, usually with buds in their axils, the terminal ones somewhat reduced, the basal lamina 1 dm long by 4 cm wide a trifle below the middle, the entire edges subinvolute in the dry state, glabrous, lucid on the upper side, curing brown, the slender acuminate apex recurved and frequently subfalcate, broadly obtuse or rounded at the base, ovately oblong, the smallest ones broadly lanceolate; veins 3 to 5, the middle one most prominent beneath and caniculate above, the lateral ones arising within 1.5 cm of the base, occasionally the upper one arising from near the middle, all subparallel, cross bars and reticulations few and faint; petiole 5 to 8 mm long; spike glabrous, stout, turning black while drying. Young infrutescence from the terminal leaf axils, ascending, 7 to 10 cm long; spike glabrous, ridged and light brown in the dry state; pedicels similar, 1 cm long, alternatingly scattered from the base, recurved,

articulated at the base and leaving large notched scars after falling; calyx saucer shaped or discoid, 1.5 mm deep and 4 mm wide across the truncate rim; corolla yellowish tinged, subcoriaceous, glabrous, united, broad and truncate at the base, narrower and only 2 mm thick across the truncate apex which is irregularly toothed, around the side more or less rugose, falling as a whole; stamens 10, inserted above the middle of the ovary and strongly bent over it; filament expanded and subglabrous at the base on the upper side, otherwise long hairy, 2 mm long; anther 1 mm long excluding the horns, oblong, truncate and emarginate at the base, frequently 2-pointed at the apex, attached on the back above the middle and which point is provided with a pair of linear ascending spurs 0.66 mm. in length; ovary one half imbedded, the upper portion flatly rounded, glabrous and rugose, 4 mm across; the strict terete styles 3 mm long, glabrous, bearing a terminal stigma.

Type specimen number 13765 *A. D. E. Elmer*, Cabadbaran (Mt. Urdaneta), Province of Agusan, Mindanao, September, 1912.

Gathered from moss laden limbs of large trees in the wet windy summit region of Mount Urdaneta at 5,750 feet altitude. The vernacular name according to the Manobos is "Duligagan."

MINDANAO, Agusan Province, Mount Urdaneta, *Elmer 13765* (M, W type): Lanao Province, *For. Bur. 25223 Alvarez* (M, W): Bukidnon Province, Kabaritan, *For. Bur., Rola s. n.* (M).

The excellent original description is in error in failing to record the puberulence of the rachis and pedicels, and overemphasizes the obscurity of the veinlets, which are evident enough, at least in the dry leaves. The cotypes fail to show the bracts and bracteoles which are so conspicuous in Alvarez's collection; however, they appear to me to show the scars where these were attached, and it is scarcely doubtful that Alvarez's collection and Rola's belong to this species.

Alvarez and Rola, on the field labels, call the plant a vine; Alvarez says the flowers are pink. He gives the elevation, the lowest of the three reported, as 3,700 feet.

SUBSECTION 2. ALLIES OF VACCINIUM BARANDANUM

Leaves mostly large, lanceolate, acuminate, margins glandular; racemes with persistent bracts; anthers with long tubes and rudimentary horns or none; disk smaller than the ovary.

This subsection may probably be regarded as a specialized offshoot from some primitive member of the preceding one. The long-tubed anthers are, to my mind, the reverse of a primitive character. This group is quite distinct from the group of *V. hasseltii*, whose members have similar anthers. *Vaccinium gitingense*, having small leaves, is included here with doubt.

3. VACCINIUM INDUTUM Vidal.

Vaccinium indutum VIDAL, Rev. Pl. Vasc. Filip. (1886) 169; MERR. in Philip. Journ. Sci. **3** (1908) Bot. 376, **7** (1912) Bot. 96, Enum. Philip. Fl. Pl. **3** (1923) 249.

Vaccinium macgregorii MERR. in Philip. Journ. Sci. **10** (1915) Bot. 53, Enum. Philip. Fl. Pl. **3** (1923) 250.

Vaccinium sorsogonense ELMER, in herb.

The original description of *Vaccinium indutum* reads:

Frutex; ramis tomentosis vel glabrescentibus. Folia breviter petiolata; petiolo 5 mm. longo, tomentoso; e basi acuta vel subcordata, ovalia vel rarius elliptico-oblonga, apice abrupte acuminata, longa 8–10 cm., lata 4–6 cm., supra pilosula vel glabrata aspera, subtus tomento denso et brevi cum pilis albidis intermixtis, praesertim ad nervos, vestita, nervatura *V. Barandani* instar. Inflorescentia villosa, ceteris ut praecedenti sed pedicellis brevioribus, bracteis foliaceis numerosis. Flores villosi, rubri. Calycis tubus hemisphaericus, dense cano-villosus; dentibus brevibus, marginatis, villoso-ciliatis. Corola campanulata; lobis brevibus, saepissime reflexis. Stamina sicut in specie priori [i. e. in *Vaccinium barandanum*].

1831 Distr. Bontoc (N. v. *Banuay.*)

Es muy afine á la anterior de la cual la distingue á primera vista el indumento que cubre casi todas sus partes verdes ménos el haz de las hojas adultas.

Of *Vaccinium macgregorii:*

Frutex erectus (vel scandens?), inflorescentiis parce pubescentibus exceptis glaber; foliis magnis, coriaceis, usque ad 18 cm longis, petiolatis, basi acutis, apice subcaudato-acuminatis, anguste ovatis ad oblongo-ovatis, basi prominente 7-plinerviis; racemis paucifloris, pubescentibus, axillaribus, solitariis, usque ad 9 cm longis, bracteolis oblongo-lanceolatis, acuminatis, 2 cm longis, deciduis; corolla rubra, 1.6 cm longa, supra leviter ampliata.

An erect (or scandent?) shrub, the branches slender, brownish, striate, somewhat ziz-zag between the distant leaves, glabrous. Leaves narrowly ovate to oblong-ovate, coriaceous, shining on both surfaces, 14 to 18 cm long, 6 to 7 cm wide, entire, the base acute, the apex slenderly subcaudate-acuminate, the base prominently 7-plinerved, sometimes with an additional outer fainter pair, the inner one or two pairs reaching the apex, the primary reticulations lax, the ultimate ones rather dense; petioles stout, 8 mm long. Racemes axillary, solitary, up to 8 cm in length, each about 10-flowered, all parts sparingly pubescent with short, white, scattered hairs, the bracteoles [bracts] oblong-lanceolate, sharply acuminate, about 2 cm long, deciduous, the pedicels 1 to 1.5 cm long. Calyx-tube cup-shaped, slightly constricted above, the limb somewhat spreading, making the whole calyx somewhat urceolate, the tube 2.5 mm long, about 3 mm in diameter, the lobes 5, broadly triangular, acute or acuminate, 1.8 mm long, margins distinctly ciliate. Corolla red, slightly funnel-shaped, rather broad, 1.6 cm long, sparingly pubescent outside, the lobes 5, short, acute or rounded, about 4 mm wide and 2 mm long. Stamens 10; filaments 9 mm long, more or less pilose with long white hairs; anthers 8.5 mm long, narrowly

oblong, base slightly curved and apiculate, the apical tubes laterally compressed, 5 mm long, the slit slightly oblique. Top of the ovary somewhat white-hispid; style 1.5 cm long, glabrous. Fruit unknown.

LUZON, Subprovince of Ifugao, Mount Polis, *Bur. Sci. 19846 McGregor*, February 11, 1913, indicated by the collector, with query, as a vine.

A species manifestly allied to *Vaccinium indutum* Vidal from which it is distinguished by its larger, more prominently nerved, glabrous or nearly glabrous leaves; from *Vaccinium barandanum* Vidal, which it also resembles, it is distinguished by the vegetative characters just indicated and its pubescent inflorescence.

LUZON, Mountain Province, *Vidal 1831* (M, fragm. ex herb. Kew, type): Lepanto Subprovince, Malamey, *Vanoverbergh 1013* (M, W): Bontoc Subprovince, Mount Caua, *Bur. Sci. 38018 Ramos and Edaño* (M, W): Ifugao Subprovince, *McGregor 1347* (M); Mount Polis, *Bur. Sci. 19846 McGregor* (M, W, type of *V. macgregorii*), *Bur. Sci. 37686 Ramos and Edaño* (M, W, C): Sorsogon Province, Mount Bulusan, *Elmer 16912, 17026* (W, C, as *Vaccinium sorsogonense* Elm.).

The specimens here cited present that familiar situation in which the herbarium worker is unable to make up his mind to his own satisfaction. The collections are few, and almost every one presents distinctive characters. The leaves vary, in their lower surfaces, from totally glabrous, through pubescent on the veins, to densely pubescent; it is to be noticed, however, that of the two collections from Mount Polis, which appear to be of the same race, one has the leaves pubescent throughout the lower surface while the other (the type collection of *Vaccinium macgregorii*) has the pubescense confined to the veins. The leaves vary also in size; the dimensions of the blades, considering characteristic leaves from different collections, vary from 9 by 4 cm to 14 by 7 cm.

The most-marked distinctive character of the group is the densely white-pubescent ovary. The truncate-conical disk is as densely pubescent as the ovary; the young branches, rachises, bracts, pedicels, bracteoles (sometimes absent?), and corollas are also pubescent, but in less degree. The margins of the leaves and of the bracts are glandular as in *Vaccinium barandanum*. I have not been able to distinguish rudimentary horns on the anthers. I have not seen fully mature fruits, but suppose that they resemble those of *Vaccinium barandanum*, differing in being pubescent and in bearing a larger crown of calyx lobes and disk.

On the basis of the characters of the inflorescence, I believe that this is a natural group, with a common ancestor distinct

from that of the *barandanum-hutchinsonii-epiphyticum* series, and accordingly feel free to treat it as a single species. As occurring in the Mountain Province it is a shrub 1 to 4 meters high, found at altitudes of 1,000 meters or more. I have seen no field notes regarding the Sorsogon material.

4. **VACCINIUM EPIPHYTICUM** Merrill.

Vaccinium epiphyticum MERR. in Philip. Journ. Sci. 7 (1912) Bot. 322, Enum. Philip. Fl. Pl. 3 (1923) 249.

The original description reads:

Frutex epiphyticus, 2 ad 3 m altus, glaber; foliis ovatis vel oblongo-ovatis, coriaceis, nitidis, acute acuminatis, basi rotundatis vel acutis, usque ad 12 cm longis, 7-plinerviis; petiolo 5 mm longo; racemis axillaribus, solitariis, quam folia brevioribus; floribus circiter 14 mm longis, cylindraceo-campanulatis, fauce vix contractis.

An epiphytic shrub, manifestly closely allied to *Vaccinium barandanum* Vid., glabrous or nearly so, 2 to 3 m high. Branches terete, smooth, grayish, the younger ones somewhat wrinkled or angular when dry, slender. Leaves alternate, ovate to oblong-ovate, coriaceous, shining, 8 to 12 cm long, 3.5 to 6.5 cm wide, the base broad and rounded or acute, 7-plinerved, the apex sharply and rather slenderly acuminate, margin entire; outer two pairs of nerves leaving the base of the leaf, the outermost ones not reaching the middle of the leaf, the next inner pair extending above the middle, the innermost pair leaving the midrib 5 to 10 mm above the base, more prominent than the others, extending nearly to the apex, the primary lateral nerves above these basal ones about 5 on each side of the midrib, ascending, not prominent, reticulations distinct; petioles 5 mm long. Racemes axillary, solitary, about 5 cm long, comparatively few-flowered, glabrous or very slightly pubescent. Bracteoles [bracts] lanceolate-oblong, acuminate, membranaceous, about 11 mm long, 4 mm wide; pedicels about 12 mm long. Flowers pink. Calyx-tube globose-ovoid, about 2 mm long, margins minutely pubescent. Corolla about 12 mm long (10 mm wide when flattened), glabrous, or with very few scattered hairs, tubular, not contracted above, the lobes broadly ovate, obtuse, reflexed, about 2 mm long. Stamens 10; filaments 5 mm long, sparingly ciliate; anthers 4 to 4.5 mm long, the terminal tubes 2 mm long, opening by pores. Style 12 mm long, pubescent.

MINDANAO, District of Zamboanga, Sax River Mountains, back of San Ramon, *Merrill 8087*, November 30, 1911, altitude about 900 m.

A species closely allied to *Vaccinium barandanum* Vidal, of Luzon and Mindoro (*Vaccinium hutchinsonii* Merr.), which it closely resembles, differing in its somewhat smaller flowers, shorter petioles, its epiphytic habit, and its pubescent, not glabrous styles.

Known only by the type collection.

The leaves are strictly glabrous beneath, with margins as in *Vaccinium barandanum;* the glandular (?) puberulence on rachises, bracts, pedicels, and ovaries is somewhat more pronounced than in the northern species. The disk is pubescent.

I have not been able to discern rudiments of horns on the anthers. It is chiefly on account of the pubescent style that I have maintained this species instead of reducing it to the rank of a variety.

5. **VACCINIUM BARANDANUM** Vidal.

Vaccinium barandanum VIDAL, Rev. Pl. Vasc. Filip. (1886) 169; MERR. in Philip. Journ. Sci. 3 (1908) Bot. 376, 5 (1910) Bot. 372, Enum. Philip. Fl. Pl. 3 (1923) 248.

The original description reads:

Frutex glaber; ramis rimoso-striatis, lenticellatis, fuscis vel cinireo-maculatis; ramulis striato-angulatis, sinuosis. Petioli 1 cm. longi, complanati, brunnei, alutaceo-rugosi. Folia e basi cuneata, oblongo-lanceolata, apice longe acuminata interdum sub-falcata, longa 10-15 cm. lata 34-45 mm., margine undato-revoluta, coriacea, basi pseudo-quinquenervia; nervis basilaribus lateralibusque ad 6 utrinque, adscendentibus. Flores majusculi, 2 cm. longi, rubri, in racemos bracteatos axillares dispositi. Calyx hemisphæricus, truncatus, 5-denticulatus, corolla multa brevior, 3 mm. longus, rugosus. Corolla anguste campanulata, lobis brevibus sæpissime revolutis. Filamenta gracilia antheris subæquilonga, glabra; antherarum loculi sicut in sect. *Epigynio d.* Hook. f. Fructus ignotus.

1532 Distr. Lepanto (N. v. *Lusong.*)

Doy á esta hermosa especie el nombre de su descubridor, el Inspector general de Montes Illmo. Sr. D. José Sainz de Baranda, á quien tantas plantas interesantes del Norte de Luzon debemos.

LUZON, Mountain Province, Benguet Subprovince, *Loher 3779* (W, M, fragm. ex herb. Kew?); Baguio, *Topping 99* (W), *For. Bur. 971 Barnes* (M, W), *Elmer 8334* (W), *For. Bur. 18334 Alvarez* (M), *Bur. Sci. 5599 Ramos* (M), *Philip. Pl. 854 Ramos* (M, W), *Sevrens s. n.* (M), *Elmer 14269* (M, W), *For. Bur. 20420 Sandkuhl* (M), *For. Bur. 21836 Leaño* (M, W, C), *Philip. Pl. 1733 Merrill* (M); *Baker 4114* (M); *For. Bur. 30192 Lagasca* (M, C), *For. Bur. 30491 Lagasca* (C); Mount Santo Tomas, *Elmer 5806* (M, W), *For. Bur. 25126 Leaño* (M, W), *Merrill 11721* (M, W); Pauai and neighborhood, *Clemens* (M), *For. Bur. 31704 Santos* (M), *Clemens 7340* (C); Tadian (?), *For. Bur. 18345 Alvarez* (M); Bucao, *For. Bur. 14423 Darling* (M); Trinidad to Tabio, *For. Bur. 15943 Bacani* (M); Mount Pulog, *For. Bur. 16073, 18096, 18053, Curran, Merritt, and Zschokke* (M): Lepanto Subprovince, Mount Data, *Merrill 4580* (M, W); Cervantes, *For. Bur. 5672 Klemme* (M, W); Mount Malaya, *For. Bur. 14500 Darling* (M); Bauco, *Vanoverbergh 1053* (M): Abra Province, Tue, *For. Bur. 14596 Darling* (M): Nueva Vizcaya Province, Carballo Mountains, *Loher s. n.* (C): Rizal Province, *Loher 12248* (M, C); Montalban, *Loher 12668* (M), *Loher 13171*

(M, C); Balacbac, *Loher 13073, 13076,* (M, C); Paningtingan, *Loher 13458* (M).

According to the collectors' field notes, this plant occurs in the mountains of northern Luzon as a tree or shrub from 2 to 8 meters high, at elevations of 1,500 meters and above. Loher's collections from Nueva Vizcaya and Rizal are without field notes. The vernacular name *lusong* is reported by several of the collectors independently.

The leaves are rather variable in shape, generally lanceolate, acuminate, totally glabrous on both surfaces, with a few very minute glands scattered along the margins, and one larger one on each margin close to the base. The peduncles and pedicels are extremely minutely and sparsely puberulent; the bracts are glabrous and ciliate, with glands along the margins; bracteoles are rarely present. The ovary bears a sparse pubescence which appears to be glandular; the calyx lobes are ciliate. The corolla is as often tubular as campanulate and is glabrous. The original description is in error in stating that the filaments are glabrous; they are decidedly hairy nearly to the summit, over 5 mm long, attached near the bases of the anthers, which are of approximately equal length. The anthers are slender, straight, split for about half their length into narrow tubes; the sacs are muriculate, the tubes smooth. One may usually detect on each anther, on the back side and at the base of the tubes, two horns; these are usually very feebly developed, but in *For. Bur. 18345 Alvarez* are quite obvious. The disk is prominent, in shape a truncate cone, glabrous; by the last character I distinguish the species from the following varieties. The style is glabrous and projects just beyond the mouth of the corolla. In ripening, the fruits turn dark red; apparently mature ones are globose, about 6 mm in diameter, conspicuously crowned by the disk and calyx lobes. The fruit is filled by ten rows of fusiform black seeds, each about 1 mm long and minutely rugose.

Var. CAGAYANENSE var. nov.

Varietas Vaccinii barandani, terrestris, disco pubescente.

LUZON, Mountain Province, Benguet Subprovince, Mount Pulogloco, *Bur. Sci. 40389 Ramos and Edaño* (M): Ifugao Subprovince, Monhoyohoy, *For. Bur. 29407 Zschokke and Laraya* (M, W, C): Nueva Vizcaya Province, Mount Alzapan, *Bur. Sci. 45596 Ramos and Edaño* (C): Isabela Province, Mount Moises, *Bur. Sci. 47300 Ramos and Edaño* (C, sheet No. 310051, type), *Clemens 16962, 16963* (C).

A shrub 2 to 4 meters high, occurring at altitudes of 1,000 meters or more, in mountains in the western part of, and west of, the Mountain Province. The strongly acuminate leaves tend to be ovate rather than lanceolate, and are very sparsely pubescent on the lower surface. The pubescence appears to be glandular, and to avoid the veins. Of the specimens that I have seen, the type is in flower; the specimen from Ifugao bears flower buds; all the others are in fruit. Except by the pubescent disk, the flowers and fruits are indistinguishable from those of the species.

Var. HUTCHINSONII (Merr.) comb. nov.

Vaccinium hutchinsonii MERRILL in Philip. Journ. Sci. 2 (1907) Bot. 294, Enum. Philip. Fl. Pl. 3 (1923) 249.

The original description reads:

Epiphyticum, glabrum, foliis late elliptico-ovatis, abrupte subcaudato-acuminatis, coriaceis, 8 ad 11 cm. longis, 5.5 ad 7 cm. latis, basi acutis; flores usque ad 17 mm. longi, rubri, in racemos bracteatos axillares dispositi, filamentis pause [pauce] setoso-pilosis.

A scandent epiphytic or pseudoepiphytic shrub about 5 m. high. Branches glabrous, light gray or brown, the younger ones somewhat angular. Leaves broadly elliptical-ovate, coriaceous, glabrous, the base acute or acuminate, the apex abruptly subcaudate-acuminate, shining, entire, 8 to 11 cm. long, 5.5 to 7 cm. wide; nerves about 7 on each side of the midrib, mostly basal, ascending, distinct, the reticulations distinct; petioles 1 to 1.5 cm. long. Racemes axillary, glabrous, 8 to 14 cm. long, the bracts oblong-lanceolate, reddish, membranous, deciduous, glabrous, acuminate, 2 cm. long, 5 mm. wide; pedicels rather distant, solitary in the axil of each bract, about 1.5 cm. long. Calyx globose, rugose, 3 to 4 mm. in diameter, the teeth 5, triangular-ovate, acute, 1 mm. long. Corolla red, tubular-campanulate, glabrous, 14 mm. long, gradually wider above. Stamens 10; filaments 6 to 7 mm. long, with few stiff hairs below; anthers narrowly oblong, 5 to 6 mm. long, the terminal tubes half the length of the anthers. Ovary glabrous; style glabrous, 15 mm. long.

Epiphytic or pseudoepiphytic in mossy ridge forests at 2,000 m. alt. [on Mount Halcon] (No. 5524).

Most closely related to *Vaccinium barandanum* Vid., from northern Luzon, differing in its much broader, relatively shorter and differently shaped more numerously veined leaves, shorter flowers and slightly setose-pilose filaments. Named in honor of *W. I. Hutchinson* of the Philippine Forestry Bureau, my companion in the ascent of Halcon.

Known only by the type collection.

The rachis and long pedicels are strictly glabrous, and the bracts are not ciliate; the disk is puberulent. These characters, together with the habit and the leaf characters noticed in the original description, are sufficient to maintain this form as a variety. The leaves are strictly glabrous beneath; the bracts

are glandular along the margins; the ovary is glandular (?) puberulent, and the calyx lobes are ciliate; in these characters, as in the pubescence of the filaments, this variety is indistinguishable from the species.

6. VACCINIUM GITINGENSE Elmer.

Vaccinium gitingense ELMER in Leafl. Philip. Bot. 4 (1912) 1490; MERR., Enum. Philip. Fl. Pl. 3 (1923) 249.

Frutex 1 ad 3 m altus; foliis coriaceis, glabris, ovatis, crenulatis, 2 cm longis, 1 cm latis, petiolis c. 2 mm longis, glabrescentibus. Flores in racemis bracteatis, rhachide glabro c. 5 cm longo, bracteis lanceolatis, glabris, 1 cm longis, margine distante glandulosis. Pedicelli graciles, c. 1.5 cm longi, glabri. Ovarium obconicum, c. 3 mm latum, lobis 5 (vel 4?) calycis ciliatis, acuminatis, c. 1 mm longis. Corolla glabra, anguste conica, minus quam 1 cm longa, lobis 5, acuminatis. Stamina 10, filamentis pubescentibus, c. 2 mm longis, antheris linearibus, filamentis subaequilongis, ad medio in tubulos duos divisis, dorso obscurissime biariatatis. Discus quam ovario minor, pubescens; stylus glaber corollae aequilongus. Fructus globosus, niger, esculentus, c. 1 cm in diametro, seminibus paucis fusiformibus, c. 1 mm longis.

The original description reads:

A low spreading bush; stem 5 cm. thick, 2 m. long, branched from the base; branches widely spreading, rigid, breaking with a snap, 1 to 2 m. long; wood hard, reddish brown except the thin sapwood, radially dotted, without odor or taste; bark coarsely checked longitudinally, dull gray; twigs terete, glabrous or the young tips faintly cinereous. Leaves rigidly coriaceous, ascending, flat, a trifle paler green beneath, curing unequally brown, the rounded basal portion entire, the sides obscurely crenately dentate, usually subinvolute, ovate to ovately elliptic, 2 cm. long, nearly 1 cm. wide below the middle, gradually acute at apex, alternate, densely scattered along the branchlets, reddish in the young state; midrib faint, the 3 to 5 lateral oblique pairs very obscure, reticulations obsolete; petiole 2 mm. long, relatively thick and much compressed, soon becoming glabrous, with a bud in the axil; calyx thick, cup shaped, glabrous, 3 mm. across, the basal portion united, the upper one half terminated into very sharply pointed 4 or 5 segments which are very finely ciliate along the edges; corolla deep red, broadly tubular, 6 mm. long, glabrous except the throat which is glauc[o]us and occasionally bears a few hairs, the 5 narrow acute or acuminately pointed apex strongly recurved in anthesis, the tube ultimately separating into the segments which are gradually narrowed from the base to the apex; stamens 10, in 2 alternating and subequal rows, all inserted upon the base of the corolla and included by it; filaments villose, averaging 1.5 mm. long, thickened toward the base, those alternating with the segments a trifle longer than the other 5; anthers pale yellow, lanceoloid, 1.5

mm. long, dehiscing at the apex through 2 slender apical prongs, dorsifixed, less than 0.5 mm. thick toward the base; style terete, 6 mm. long, thick and fleshy, 2-pointed at the apex, bearing a granular flattish stigma; fruit globose, glabrous, at least 5 mm. in diameter, the circular apical portion covered over by the 5 persistent sharply pointed calyx teeth.

Type specimen 12555, *A. D. E. Elmer*, Magallanes (Mt. Giting-giting), Province of Capiz, Island of Sibuyan, May, 1910.

Only found in hot dry sand gravelly soil along the Pauala river bottom above 750 feet elevation. In all probability washed down from the summit region of mount Giting-giting. "Pagang-pang" is its Visayan name.

Distinct from *V. villarii Vid.* and *V. whitfordii Merr.* of our Philippine species, and from *V. coriaceum Hook.* of mount Kina-balu, British North Borneo.

SIBUYAN, Capiz Province, Mount Giting-giting, *Elmer 12555* (W, S). MINDANAO, Surigao Province, Tubungan Dayan, *For. Bur. 26005 Mallonga* (M, W); Iron Deposit, *Bur. Sci. 34577, 34591 Ramos and Pascasio* (M, W), *Bur. Sci. 34262 Ramos and Pascasio* (M).

The cotypes are not very revealing, being without flowers. The specimens from Surigao agree with the cotypes in all the characters which the cotypes show, the fruits being more fully developed; it is not, however, unlikely that they represent a distinct species. The field notes state that the flowers are white; in the dry state they are dark red. The leaves are glabrous, excepting the petioles; the marginal glands, occurring at intervals of a few millimeters, are produced in notches, and produce the crenulate margin which this species shares with *Vaccinium whitfordii*. The young branchlets are puberulent, as are the rachises. The bracts resemble the leaves very closely, although they are smaller, so that one might almost take this species as one with axillary flowers. The corolla shows no trace of splitting into five segments. Any alternation of the stamens in these flowers is very obscure, if it occurs at all. The anthers are 2 to 3 mm long, very slender, split throughout the upper half into slender tubes, and bear obscure horns on the dorsal side. The disk is moderately prominent, puberulent in the middle. The maturing fruit turns from green through red to black; at maturity it is about 1 cm in diameter, and is edible, the taste being described as sweet. The seeds are reddish brown, fusiform, about 1 mm long; only a few are developed, and these are found near the middle of the fruit, not in recognizable rows.

The plant is a shrub found at low elevations. It is chiefly on the basis of the shape of the anthers that I regard it as

related to *Vaccinium barandanum* and *V. indutum*, though by no means as close to these as they are to each other.

SUBSECTION 3. ALLIES OF VACCINIUM PERRIGIDUM

Plants usually epiphytes; leaves large, of various shapes; racemes without bracts; pedicels stout; corolla about 1 cm long; anthers bulky, about 3 mm long, without horns and not narrowed into tubes; disk glabrous, more bulky than the ovary.

In diagnostic characters, *V. perrigidum* and *V. alvarezii* show close resemblance to the plants of Subsection 5; the latter group, however, seems to arise from *V. bancanum*, while this one seems to arise from *V. sarawakense* and *V. hosei*. These are Bornean species which seem to connect the present group with Subsection 1.

7. VACCINIUM PERRIGIDUM Elmer.

Vaccinium perrigidum ELMER in Leafl. Philip. Bot. 3 (1911) 1094; MERR., Enum. Philip. Fl. Pl. 3 (1923) 251.

Frutex epiphyticus ad 5 m altus. Folia coriacea, lanceolata, basi rotundata, apice acuminata, margine integra glandula utrinque una basile excepta, ad 10 cm longa, petiolis glabris, crassis plus quam 1 cm longis. Flores in racemis ebracteatis, rhachide glabro 5 ad 8 cm longo, pedicellis recurvis, glabris c. 1 cm longis. Ovarium calyciforme glabrum, c. 3 mm latum; lobis 5, calycis rotundatis, ciliatis, c. 1 mm longis. Corolla urceolata, alba, 0.12 mm longa, lobis 5, recurvis, purpureis, minus quam 1 mm longis. Stamina 10, filamentis aplanatis, pubescentibus, 5 mm longis, antheris oblongis, c. 3 mm longis, dorso muticis, poris hiantibus. Discus quam ovario maior, glaber; stylus glaber, corollae aequilongus. Fructus globosus, 9 mm diametro, cum disco aplanato 6 mm in diametro coronatus, intus spuriose 10-loculatus, loculis plurispermis; semina fusiformia, fusca, c. 2 mm longa.

The original description reads:

An epiphytic shrub; stem[s] usually few, branched all along, the larger ones 5 m. long; wood whitish, tough, covered with smooth grayish bark, brown on the branches. Leaves rigidly coriaceous, not numerous, alternatingly scattered, glabrous, horizontal or descending, sublucid on both sides, deep green above, paler so beneath, flat or shallowly conduplicate on the upper side, the acute or slenderly acuminate tips recurved, young leaves pale green, entire margins subinvolute in the dry state, oblong to elliptish, [sic] base rounded or short obtuse, the larger blades 1 dm. long by 4.5 cm. wide across the middle or immediately below it, turning brownish green while drying; petiole stout, also glabrous, reddish brown, nearly

black when dry, 1 cm. long or longer; nerves equally pronounced on both sides, the midrib usually with 2 pairs of lateral ones arising from near the base and curvingly extending to the base of the tip, the 1 to 3 secondary lateral pairs rather obscure, reticulations evident. Inflorescence chiefly terminal or from the uppermost leaf axils, spicately racemose; rachis smooth, more or less crooked, 5 to 8 cm. long, bearing scattered flowers along its entire length, ascending or divaricate; pedicels recurved, similarly green and shining, stout, 1 cm. long; calyx also green, flatly turbinate, 4 mm. high, 6 mm. across, glabrate except the finely ciliate margins of the 5 whitish and broadly rounded segments; corolla flask shaped, waxy white except the 5 small purplish reflexed segments, 12 mm. long, 8 mm. across the base, 2.5 mm. across the top, becoming detached from the calyx; stamens 10, inserted upon the base of the corolla; filaments white, widely expanded toward the base, hairy below the middle, 5 mm. long, slenderly tapering; anthers 2.5 mm. long, oblong with truncate or minutely lobed ends, the upper one half easily separating, dorsally attached, beaks entirely wanting, dehiscent through large special pores; ovary inferior; style 12 mm. long, glabrous, columnar, also whitish, bearing a terminal green stigma; fruits not seen.

Type specimen 11686, *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, September, 1909.

Collected from the lower limbs of large lofty trees on a forested ridge at 5,500 feet of mount Calelan. A coarse and rigid plant in all its parts. The Bagobos call it "Basisir."

MINDANAO, Davao Province, Mount Apo, *Elmer 11686* (M, W, S): Agusan Province, Mount Urdaneta, *Elmer 13281* (M).

The whole plant, excepting the ciliate calyx lobes and pubescent filaments, is strictly glabrous. The leaves bear one marginal gland on each side of the blade, near the base. The fruit, seen in the Agusan specimen, is (in the dry state) black, 9 mm in diameter, crowned by the disk, which is now flat and 6 mm in diameter. Internally there is a peripheral thick layer of pulp, woody in the dry state; the seeds, in 10 rows in 5 cavities which are V–shaped in cross-section, are dark brown, fusiform, longitudinally striate, 2 mm long.

8. **VACCINIUM ALVAREZII Merrill.**

Vaccinium alvarezii MERR. in Philip. Journ. Sci. 4 (1909) Bot. 304, Enum. Philip. Fl. Pl. 3 (1923) 247.

Vaccinium turbinatum MERR. in Philip. Journ. Sci. 10 (1915) Bot. 54, Enum. Philip. Fl. Pl. 3 (1923) 252.

The original description of *Vaccinium alvarezii* reads:

Arbuscula glabra circiter 3 m alta; foliis oblongo-obovatis vel eliptico-oblongis, coriaceis nitidis, integris, usque ad 10 cm longis, breviter obtuse acuminatis, nervis utrinque 5 vel 6, ascendentibus, tenuibus; racemis axillaribus, solitariis vel binis, foliis b[r]evioribus; corolla cylindracea, leviter inflata, circiter 1 cm longa; staminibus 10, antheris scaberulis, dorso

vix aristatis, apice breviter productis appendicibus infundibuliformibus, divaricatis, poris apicaliter dehiscentibus.

A glabrous shrub about 3 m high. Branches reddish-brown, somewhat mottled with gray, terete. Leaves oblong-ovate to elliptic oblong, 6 to 10 cm long, 2.5 to 5.5 cm wide, entire, the apex shortly and obtusely acuminate, the base acute, margins slightly recurved, shining on both surfaces; nerves 5 or 6 on each side of the midrib, slender, not prominent, ascending, anastomosing, the reticulations lax; petioles 4 to 6 mm long. Racemes axillary, solitary or in pairs, 3 to 5 cm long, the pedicels about 1.5 cm long, articulated with the calyx. Calyx-tube short, the lobes broadly ovate, obtuse, 1.5 to 2 mm long, each lobe gland tipped. Corolla pink, cylindric, 10 to 11 mm long, about 5 mm in diameter, slightly inflated in the mid[d]le, the lobes erect, ovate, obtuse, 1.5 to 2 mm long. Stamens 10; filaments 4 to 5 mm long, white-villous; anthers 3 mm long, scaberulous, not awned, the apex produced into two short, broad, funnel-shaped divergent tubes, opening by terminal, orbicular pores. Disk prominent crenate-undulate; style 1 cm long.

LUZON, Province of Cagayan, Dalisay River, *For. Bur. 18466 Alvarez,* March, 1909, in forests, altitude about 650 m.

Probably most closely allied to *Vaccinium barandanum* Vid., and *V. benguetense* Vid., but quite distinct from both.

Of *Vaccinium turbinatum:*

Frutex epiphyticus, glaber; foliis crasse coriaceis, obovatis ad anguste obovatis, usque ad 9 cm longis, obtusis vel abrupte breviter obtuseque acuminatis, basi acutis, integris, margine revolutis, nervis utrinque 6, tenuibus, adscendentibus; floribus ignotis; racemis in axillis superioribus vel terminalibus, fructibus longe pedicellatis, turbinatis, circiter ⅓ superioribus, 7 mm diametro.

An epiphytic glabrous shrub (flowers unknown), the branches olivaceous or brownish and more or less sulcate when dry, the growing parts reddish-brown. Leaves thickly coriaceous, obovate to narrowly obovate, 5 to 9 cm long, 2.5 to 5 cm wide, apex obtuse or abruptly, broadly, shortly, and obtusely acuminate, the base acute, entire, the margins revolute, with usually one or two pairs of prominent glands above the insertion of the petiole, shining on both surfaces, the upper surface pale, the lower one brownish when dry; lateral nerves about 6 on each side of the midrib, ascending, slender, not prominent, anastomosing; petiole stout, 5 to 7 mm long; bracteoles deciduous (not seen). Flowers unknown. Racemes, in fruit, about 5 cm long, in the uppermost axils or terminal, solitary, few, the pedicels about 1.5 cm long, thickened upward and about 2 mm thick at the apex, distinctly jointed to the calyx. Fruit turbinate, about 5 mm in diameter, one-third superior, the persistent calyx-teeth broadly triangular, acute or obtuse, about 2 mm long.

LUZON, Province of Laguna, San Antonio, in forests on trees, *Bur. Sci. 15068 Ramos,* June, 1912.

A characteristic species distinguishable by its fruit being one-third superior, the rounded upper part of the fruit as wide as the calyx in its thickest part, protruding above the persistent calyx-teeth. The plant somewhat resembles *Vaccinium jagori* Warb. in vegetative characters, but has larger, longer petioled leaves.

LUZON, Cagayan Province, Dalisay River, *For. Bur. 18466 Alvarez* (M, type); without locality, *For. Bur. 16718 Curran* (M): Rizal Province, Montalban, *Loher 12761* (M, C); Mount Irig, *Bur. Sci. 40743 Ramos* (M): Laguna Province, neighborhood of Paete, *Bur. Sci. 15068 Ramos* (M, W, type of *V. turbinatum*), *For. Bur. 23476 Villamil* (M), *For. Bur. 26820 Catalan* (M), *For. Bur. 26767 Mabesa* (M, W).

This plant has usually been found as an epiphyte; the altitudes reported range from 100 to nearly 2,000 meters. The flowers are white, pink, or red. The two descriptions quoted above are excellent characterizations of the same species as collected in different stages at different localities. The flowers as collected in Laguna (*Villamil*) are exactly like those of the type.

The leaves are large and vary in shape from narrowly or broadly elliptic to oblanceolate or broadly obovate; they are nearly always broadly and briefly acuminate. The leaves (except for the basal glands), stems, rachises, pedicels, ovaries, corollas, disks, and styles are strictly glabrous. The barrel-shaped corolla, and the anthers, large, verruculose, lacking horns, and with short divergent tubes, are very characteristic, and distinguish this species from its nearest relative, *Vaccinium perrigidum*. The fruit is smaller than that of *Vaccinium perrigidum*, but altogether similar in appearance and structure. The seeds are black, fusiform, about 1.5 mm long.

Var. MOISENSE var. nov.

Varietas Vaccinii alvarezii, ovario disco internisque corollae pubescentibus.

LUZON, Isabela Province, Mount Moises, *Bur. Sci. 47303 Ramos and Edaño* (C). An epiphyte with red flowers, altitude 900 meters.

This form is very close to the species. The segregation is based upon very definite characters, the pubescence of the ovary, disk, and internal surface of the corolla.

SUBSECTION 4. ALLIES OF VACCINIUM CAUDATUM

Leaves of moderate size; racemes with small bracts or none; pedicels slender; anthers with long tubes but no horns; disk as bulky as the ovary.

Some of the Javan species of Subsection 1 have anthers with long tubes and extremely minute horns. From these it is easy to derive *V. perakense* Ridley, of the Malay Peninsula; and from the latter, by reduction of the leaf size, *V. decorum* Ridley and *V. viscifolium* King and Gamble may have originated. The

widespread "collective species" which goes by the name of *V. hasseltii* Miquel, is, I believe, a close relative of these. I have seen specimens of *V. hasseltii,* from the Malay Peninsula, with rather small leathery leaves, pubescent rachises, and evident bracts; this form should probably be raised to specific rank. I have likewise seen among the Malay Peninsula and Sumatran specimens, a form which I suppose to be typical of the species, with thinner, larger, more attenuate leaves, glabrous rachises, and longer flowers. With considerable doubt, I have concluded that the Philippine *V. caudatum* and *V. benguetense* are to be maintained as species distinct from this.

9. VACCINIUM CAUDATUM Warburg.

Vaccinium caudatum WARBURG in Perk. Fragm. Fl. Philip. (1905) 173; MERR. in Philip. Journ. Sci. **3** (1908) Bot. 376, Enum. Philip. Fl. Pl. **3** (1923) 248.

Vaccinium sp. VIDAL, Phan. Cum. Philip. (1885) 25, 123.

The original description reads as follows:

Ramis teretibus cinereis striatis, lenticellis haud distinctis, ramulis angulose striatis in sicco cinereis; petiolis gracilibus 5—6 cm longis ¾ mm latis, foliis subcoriaceis lanceolatis basi acutis apice longe et vulgo subcurvate vel acumine obtuso cuspidatis, 4—6 cm longis, 1½—2 cm latis in sicco supra glauce fuscescentibus, subtus fuscescentibus, indistinctis quintuplinerviis, venis utrinque 4—5 vix, nervis tertiariis haud conspicuis. Racemis axillaribus et terminalibus quam folia sublongioribus, bracteis nullis (vel deciduis), pedicellis tenuibus 4 mm longis, floribus haud nutantibus, calyce late infundibuliformi apice 5-dentato, dentibus late triangularibus breviter acuminatis; perigonio urceolato 5 mm longo 2—3 cm lato, ore subangustato, lobis latis recurvatis obtusis, filamentis brevibus glabris filiformibus, loculis parvis saccatis in tubulos rectos longissimos glabris productis; stylo columnari; fructu globoso infra apicem calyce coronato, in sicco nigro.

Philippine Isl. (CUMING no. 905 with flowers); Luzon Isl., Prov. Laguna, Siniloan (WARB. no. 13753).

Philippine Islands without locality [Luzon, Albay Province, ex Cuming's list in herb. Kew, fide Merr. in Philip. Journ. Sci. 3 (1908) Bot. 376], *Cuming 905* (M, C, fragm. ex M, type collection): Laguna Province, Siniloan, *Warburg 13753* (M, cited in original description); Paete, San Antonio, and neighborhood, *Bur. Sci. 14970 Ramos* (M, W), *Bur. Sci. 22771, 22865 McGregor* (M), *Bur. Sci. 22879 McGregor* (M, W): Rizal Province, Montalban, *Loher 12154* (M, C); Balacbac, *Loher 14965* (M). MINDORO, Magasauangtubig, *For. Bur. 12033 Rosenbluth* (M), *For. Bur. 12194 Rosenbluth* (M, W). PANAY, Capiz Province, Libacao, *Bur. Sci. 35450 Martenilo and Edaño* (M, C); Mount Salibongbong, *Bur. Sci. 35609 Martelino and Edaño* (M, W, C): Ilo-

ilo Province, Ulian River, *Bur. Sci. 18238 Robinson* (M, W). LEYTE, Jaro, *Wenzel 1118* (M). MINDANAO, Surigao Province, Placer, *Wenzel 3001, 3119, 3443, 2G* (C).

A note in Merrill's handwriting on the cotype reads: "Very near benguetense Vid. & prob. only a form of it. Differs in the smaller leaves & shorter petioles, the nerves less distinct & fil. glabrous." This note and Warburg's description are in error at one point: the filaments are actually pubescent at the base; the stamens are exactly as in most specimens of *V. hasseltii* and *V. benguetense.* I find two slight distinctive characters in the flowers, both noticed in the original description: the calyx lobes are evident and slightly acuminate, and the corolla lobes are often recurved. As collected in Luzon, Mindoro, and Panay this is a shrub or tree; in Leyte and Mindanao, an epiphyte. Most of the collections are from altitudes of less than 500 meters. The occurrence of this species, southward of and more widely distributed than *V. benguetense,* leads me to regard it as ancestral to the latter.

10. VACCINIUM BENGUETENSE Vidal.

Vaccinium benguetense VIDAL, Rev. Pl. Vasc. Filip. (1886) 168; MERR. in Philip. Journ. Sci. **3** (1908) Bot. 376, **5** (1910) Bot. 372, Enum. Philip. Fl. Pl. **3** (1923) 248.

Vidal's original description reads as follows:

Frutex glaber; ramis striatis, lenticellatis, teretibus; ramulis striatis, sub-angulatis. Petioli 10-15 mm. longi, canaliculati sæpissime complanati. Folia e basi acuta vel cuneata, in petiolum leviter decurrentia, oblonga aut elliptico-oblonga aut rarius ovalia, apice sæpissime longe et abrupte acuminata, acumine obtuso, longa 7-10 cm. lata 2-4 cm., coriacea, integerrima vel leviter undulata, margine revoluta, supra nitida subtus concolora pallidiora; basi pseudo-quinquenervia; nervis basilaribus lateralibusque adscendentibus, reticulatis, interdum bifurcatis, ad 6 utrinque. Racemi laterales foliis sub-æquantes vel longiores, multiflori. Calyx hæmisphericus, ad 2 mm. longus, quinquedentatus; dentibus brevibus, vel sub-nullis. Corolla, ad 5 mm. longa, urceolata, ore contracta; lobis brevibus, rotundatis, revolutis; rubra, in sicco fusca. Filamenta brevia, lanata; antherarum loculi in tubulos rectos longe producti, rimis anticis elongatis dehiscentes (Sect. *Epigynium, d.* Hook. f.), e basi saccati, glabri. Fructus globosus, apice ample areolatus, ad 7 mm. diam., nigricans.

1515, 1534 Distr. Benguet.

LUZON, Mountain Province, Benguet Subprovince, Baguio, *Elmer 8663* (M, W), *Santos 9* (M); Bugias, *Merrill 4653* (M, W); Mount Pulog, *For. Bur. 18206 Curran, Merritt, and Zschokke* (M, W); Mount Data, *Loher 3777* (M): Lepanto Subprovince, Mankayan, *For. Bur. 10930 Curran* (M); Bauko *Vanover-*

bergh 55 (M, W): Bontoc Subprovince ?, Mount Masapilid, *Bur. Sci. 37892 Ramos and Edaño* (M, W): Kalinga Subprovince?, Bolinao, *For. Bur. 17006 Curran* (M): Abra Province, *For. Bur. 14600, 14661 Darling* (M): Ilocos Norte Province, Mount Piao, *For. Bur. 14000 Merritt and Darling* (M); Ilocos Sur Province, *For. Bur. 25488 Paraiso* (M): Zambales Province, Mount Pinatubo, *Loher 6041* (M), *Bur. Sci. 2564, 2566 Foxworthy* (M), *Bur. Sci. 2579 Foxworthy* (M, W), *Clemens 17467, 17468* (C); Mount Tapulao, *Bur. Sci. 4983 Ramos* (M, W): "Luzon Central," Bulacloco, *Loher 3781* (W, M, fragm.).

A shrub or tree, 4 to 10 meters high, from elevations of 1,000 meters or more The leaves of many specimens fail to reach the dimensions given in the original description; the specimens from Zambales, especially, are scarcely distinguishable from *Vaccinium caudatum.* The leaves bear, generally, a single marginal gland near the base on each side; the veins are conspicuous on the lower surface, on which a lens will usually reveal minute scales. The ovary is glabrous, the lobes, as stated in the original description, often obscure, the disk moderately prominent, glabrous, the style glabrous. The corolla varies from red to pink, or white. The usually sigmoid filaments are about 2 mm long; in most specimens the pubescence on these is confined to the base. The anther consists of a muriculate horizontal portion about 1 mm long, and, at a sharp angle to this, two slender tubes about 3 mm long.

SUBSECTION 5. ALLIES OF VACCINIUM LUZONIENSE

Leaves usually with only one or two glands on each margin near the base mostly of moderate size, attenuate at both ends; corolla urceolate; anthers small, with short tubes and small horns or none; disk usually about as bulky as the ovary.

I have not been able to reach a conclusion as to whether this group is derived from Subsection 1 by a reduction of the size of the leaves, or whether it is of independent but closely related origin.

The widespread group which is called *V. bancanum* Miquel includes races very similar in appearance to *V. hasseltii.* Close to it (the lines of descent are not clear) we may place the Bornean *V. flagellatifolium*,[9] *V. moultonii* Merrill, and *V. bigibbum*

[9] *Vaccinium flagellatifolium* nom. nov. pro *Vaccinium caudatifolium* Merr. In Journ. Str. Br. Roy. As. Soc. 76 (1917) 103, non Hayata in Ic. Pl. Formosa 3 (1913) 127, *t. 22.*

J. J. Smith; the Javan *V. leptanthum* Miquel; and possibly also *V. acuminatissimum* Miquel, of Java and Borneo. The Philippine species *V. suluense* and *V. elegans* are apparently to be derived immediately from *V. bancanum. Vaccinium tenuipes* and *V. luzoniense* do not agree with them (nor with each other) in all ways, but may, I think, confidently be ascribed to the same circle of relationship. *Vaccinium irigaense* and *V. platyphyllum* are sharply distinct species, assigned to this series with considerable doubt.

11. VACCINIUM SULUENSE sp. nov.

Vaccinium sp. MERR. in Philip. Journ. Sci. **29** (1926) 409.

Arbor parva, 3 ad 7 m alta; folia ovata, basi rotundata ad breviter cuneata, apice saepissime breviter acuminata, 4 ad 7 cm longa, 2.5 ad 4 cm lata, supra lucida, subtus fusca, obscure punctata, margine integra glandulis prope basin utrinque 1 vel 2 exceptis; nervis subpalmatis reticulatis utrinque manifestis; petiolis c. 4 mm longis; rhachides racemorum ebracteatorum glabrae foliis sublongiores, pedicellis gracilibus glabris 3 ad 6 mm longis; ovarium late obconicum, c. 2 mm latum, lobis calycis 5 minus quam 1 mm longis, ovatis, acuminatis, obscurissime ciliatis vel glabris; corolla ignota; stamina 10, filamentis sigmoideis basi applanatis puberulentibus, antheris oblongis 1.5 mm longis, medio in tubulos duos divisis, dorso biaristatis; discus ovario aequans, glaber vel parcissime puberulens; stylus ignotus; fructus caeruleus oblato-sphaeroideus, diametro c. 6 mm. cum lobis calycis, circum discum 3 mm latum erectis, coronatus, intus spuriose 10-loculatus, loculis plurispermis; semina fulva, fusiformia, c. 2 mm longa.

BALAMBANGAN ISLAND (British North Borneo), *Wood 1731* (C; type). SULU, *Clemens 9337* (M). MINDANAO, Bukidnon Province, Mount Maraniag, *For. Bur. 30277 Rojas* (M, C).

The type, collected in May, 1923, is from a shrub 10 feet high on a hill 10 feet above sea level, and is slightly past flowering. Merrill, considering the condition of the specimen, neither identified nor described it. I have done so upon finding two rather unsatisfactory Philippine specimens which match it well. The specimen from Sulu is sterile, and was taken from a tree at 2,400 feet elevation; the specimen from Bukidnon is in fruit, and came from a tree at 200 feet elevation.

Very close to *V. bancanum* Miquel, which has relatively more-slender leaves and (if I construe it correctly) pubescent rachises, pedicels, ovaries, calyx lobes, disks, and styles.

12. VACCINIUM ELEGANS Elmer.

Vaccinium elegans ELMER in Leafl. Philip. Bot. 3 (1911) 1093; MERR. Enum. Philip. Fl. Pl. 3 (1923) 249.

Arbor 10 m altus. Folia glabra, subcoriacea, lanceolata, basi acuta, apice acuminata, margine obscure distante glandulosa, 5 cm longa, 2 cm lata, petiolis 2 mm longis, glabris. Flores in racemis ebracteatis, rhachide glabra 3 ad 5 cm longa, pedicellis glabris, gracilibus minus quam 1 cm longis. Ovarium calyciforme glabrum, c. 2 mm latum, lobis calycis obtusis, ciliatis, c. 1 mm longis. Corolla albida, urceolata, glabra, 6 mm longa, lobis minutis, obtusis, recurvis. Stamina 8 ad 12, saepius 10, filamentis pubescentibus, 2.5 mm longis, antheris ovoideis, c. 1 mm longis, dorso obscurissime biaristatis, medio in tubulos duos divisis, tubulis introrse deflexis, poris hiantibus. Discus pubescens ovario aequans; stylus glaber, corollae aequilongus. Fructus ignotus.

The original description reads:

Tree 10 m. high, 3 dm. thick or more; its main branches arising from below the middle, the branches horizontally spreading, the ultimate ones lax and numerous; wood hard, heavy, reddish toward the middle, odorless; the bark dark brown, coarsely shredded longitudinally, smooth and grayish on the branchlets, the twigs green and glabrous. Leaves horizontal and recurved, alternatingly scattered along the branchlets, thinly coriaceous, shining deep green above, much paler green beneath, the young terminal leaves reddish and pendulous, entire margins subinvolute in the dry state, glabrous, the lower surface brown and the upper side nearly black when dry, elliptic to oblanceolate or oblongish, 5 cm. long, 2 cm. wide across the middle, acute but occasionally obtuse or cuneate, gradually tapering into the acuminate or caudate apex; petiole 3 mm. long, glabrous; midrid prominent beneath, grooved along the upper side; the lateral 4 to 6 pairs ascending, relatively faint, reticulations visible from both sides. Spicate racemes terminal or from the uppermost leaf axils, ascending, 3 to 5 cm. long, glabrous; pedicels less than 1 cm. long, divaricate, not numerous and scattering all along the rachis, glabrate or minutely glandular hairy, usually recurved; calyx glabrous except the minutely ciliate margins, broadly cup shaped, 4 mm. across, with 5 blunt and callous tipped teeth; corolla 6 mm. long, broadly cylindric, whitish, constricted toward the apex, glabrous, with 5 small recurved segments, inserted upon the calyx below their teeth; stamens 8, inserted upon the base of the corolla; filaments 2.5 mm. long, widest and flattened toward the base, hairy; anther subauriculate and nearly basifixed, the upper incurved portion deeply cleft, with only short hairs, oblong, 1 mm. long; style smooth, striate, 5 mm. long, columnar, bearing a small terminal stigma; ovary inferior; fruit not seen.

Type specimen 11683 *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, September, 1909.

Discovered in dense woods or forests on a ridge at 6,500 feet of mount Calelan.

Only one tree was found during the last month of my seven months' exploration work. An elegant species with lax branchlets, pleasing green foliage and waxy white flowers! "Mandalogong" is the vernacular Bagobo name.

Remotely resembling *V. hasseltii* Miq., but the anther beaks not at all as described in that species.

Known only by the type collection (M, W, S).

The lanceolate, acuminate leaves bear minute glands at intervals all along the margins, but appear not to be glandular on the lower surface. I have been unable to detect any pubescence on the pedicels. The pubescent disk is prominent, about as bulky as the ovary. In different flowers I have seen 9, 10, 11, and 12 stamens; the flower with 12 stamens had 6 calyx lobes. The anthers are muriculate along the angles, not hairy at all, of very characteristic appearance; ovoid; the brief tubes bent inward at a decided angle, and bearing flaring pores; with rudimentary horns on the back, at the base of the tubes.

I believe this species is close to *V. bancanum* and *V. suluense*, but not to *V. hasseltii.*

13. VACCINIUM LUZONIENSE Vidal.

Vaccinium luzoniense VIDAL, Rev. Pl. Vasc. Filip. (1886) 168; CERON, Cat. Pl. Herb. Manila (1892) 105; MERR. in Philip. Journ. Sci. 3 (1908) Bot. 377, Enum. Philip. Pl. 3 (1923) 250.

The original description reads:

Frutex glaber. Ramuli rugoso-rimosi, lenticellati. Petioli 1 cm., complanati, canaliculati, alutaceo-rugosi, fusci. Folia e basi cumeata, ovalia vel elliptico-oblonga, apice passim abrupte obtuso-acuminata, longa 7-9 cm. lata 30-45 mm., integerrima margine revoluta, coriacea, subtus pallida; basi pseudo-quinquenervia, rarius trinervia; nervis inferioribus adscendentibus. Racemi axillares vel pseudo-terminales, foliis sub-æquantes vel parum longiori; multiflori. Alabastra conica. Flores rubri, in sicco fusci, pedicellati, sæpissime cernui. Calyx basi lata; lobis rotundato-triangularibus; rugosus. Corol[l]a conico urceolata, ore angusta; lobis brevibus, rotundatis, sæpissime reflexis; ad 1 cm. longa. Stamina basi tubi corollæ adherentia; filamentis glabris, gracilibus, anthæris multo longioribus; anthærarum loculi non producti, poris dehiscentes (Sect. *Epigynium a.* Hook. f.).

1535 Distr. Lepanto.

LUZON, Mountain Province, Benguet Subprovince, Baguio, *Williams 1296* (M, W), *For. Bur. 5143 Curran* (M, W); Pauai, *Bur. Sci. 31880 Santos* (M); Loo, *Loher 3775* (M, W, fragm. ex Herb. Kew); Mount Santo Tomas, *Loher 3776* (W): Lepanto Subprovince, Mancayan, *For. Bur. 10932 Curran* (M, W): Ifugao and Bontoc Subprovinces, *For. Bur. 29410 Zschokke and Laraya* (M, C).

A shrub or small tree, confined to the Mountain Province, apparently not very common, at altitudes from 1,500 to 2,100 meters. The elliptic and slightly acuminate leaves are coriaceous, pallid, strictly glabrous except for one marginal gland on each side near the base, often somewhat smaller than indicated in the original description; the reticulate venation is prominent on both surfaces. Merrill (1908) remarks: "The species can be readily recognized by the peculiar capitate-glandular hairs on the inflorescence, this character being found in only one other known Philippine species, the very different *V. tenuipes*." The glandular hairs are found chiefly on the rachis, but extend to some extent onto the pedicels and ovaries; they may also be detected on the young stems and the petioles. Simple hairs are usually completely absent, but may sometimes be seen on the stems and petioles. Bracts are absent; bracteoles may sometimes be detected, but are usually represented, on each pedicel, by two minute warts near the base. The longitudinally compressed ovary is exceeded in bulk by the prominent disk; these and the style are glabrous, except for the glandular hairs sometimes found on the ovary. The corolla is described on the field labels as pink or red. The original description is in error in describing the filaments as glabrous; they are sparsely pubescent, especially toward the base. The oval anthers are without tubes or horns, the pores gaping widely. The mature fruits, seen in only one collection (*Williams*), are apparently black, globular, about 8 mm in diameter, the upper one-third belted by the persistent calyx, obscurely 10-ridged; the interior containing five cavities, each cavity nearly divided into two by a ridge extending in from the periphery, the walls of the cavities cellular-pulpy; the seeds, forming one row in each of the ten half-cavities, are linear, black, rugulose, 1 mm long.

14. **VACCINIUM TENUIPES Merrill.**

Vaccinium tenuipes MERR. in Philip. Journ. Sci. 3 (1908) Bot. 375, Enum. Philip. Fl. Pl. 3 (1923) 251.

Vaccinium sp. MERR. in Philip. Journ. Sci. 2 (1907) Bot. 295.

The original description reads:

Arbuscula epiphytica vel terrestris usque ad 3 m alta;, ramulis racemisque plus minus pubescentibus et capitellato-stipitato-glandulosis; foliis coriaceis, ovatis, oblongis, vel oblongo-lanceolatis, 3 ad 5 cm longis, basi rotundatis, apice longe caudato-acuminatis; racemis axillaribus, folia aequantibus vel superantibus, tenuibus; floribus longe pedicellatis, corrolla 1 cm longa, anguste conico-urceolata; staminibus 10; antheris vix productis, poris orbicularibus dehiscentibus.

A terrestrial or epiphytic shrub about 3 m high. Branches terete, glabrous, gray or blackish when dry, the branchlets slender, somewhat pubescent, and with numerous, long, spreading, capitellate-glandular hairs, which are also found on the inflorescence. Leaves alternate, ovate to oblong or even oblong-lanceolate, 3 to 5 cm long, 1 to 2.5 cm wide, coriaceous, shining, glabrous, brown when dry, the base rounded, the apex long and slenderly caudate-acuminate, the acumen usually one-third the length of the leaf, the margins strongly recurved; nerves obsolete or nearly so; petioles about 3 mm long, glabrous. Racemes axillary, solitary, about as long as the leaves, very slender, few-flowered, somewhat pubescent and with numerous spreading capitate-glandular hairs, the pedicels slender, 1 to 2 cm long, each with one or two lanceolate, acuminate, about 1.5 mm long bracts in the lower part. Calyx-tube short, the lobes 5, triangular-ovate, acute or slightly acuminate, about 1.5 mm long. Corolla pink or red, glabrous, narrowly conical-urceolate, 1 cm long, about 4.5 mm in diameter below, the upper half narrowed and about 2 mm in diameter above, the lobes 5, broadly ovate, obtuse, 1 mm long, erect. Stamens 10, inserted on the base of the corolla; filaments 3 mm long, lanate below, attenuate above; anthers oblong, 1.5 mm long, the apex not produced, truncate, opening by two orbicular pores, the back not spurred. Disk prominent, rugose, glabrous or nearly so; style stout, 1 cm long, somewhat pilose.

LUZON, Province of Cagayan, Caua Volcano, *R. N. Clark*, August, 1908, altitude about 900 m. MINDORO, Ibalo River, *For. Bur. 11485 Merritt*, May, 1908, altitude about 600 m; Mount Halcon, *Merrill 6133*, November, 1906, sterile, altitude about 1,500 m. NEGROS, Cuernos Mountains, *Elmer 9819, 10108*, altitude about 1,200 m.

A species of the section Epigynium, well characterized by its very strongly caudate-acuminate, almost nerveless leaves, very slender few-flowered axillary racemes and long-pedicelled flowers, and especially by the numerous long-capitate-glandular hairs on the young branches and inflorescence.

LUZON, Cagayan Province, Caua Volcano, *R. N. Clark* (M, type): Mountain Province, Benguet Subprovince, Mount Pulog, *Bur. Sci. 45021 Ramos and Edaño* (M, C); Mount Pulogloco, *Bur. Sci. 40404 Ramos and Edaño* (M, W): Ifugao or Bontoc Subprovince, South Inomin, *For. Bur. 29412 Zschokke and Laraya* (M, C): Rizal Province, Montalban, *Loher 12665* (M); Angilog, *Loher 14173* (M, C). MINDORO, Mount Halcon, *Merrill 6133* (M); Ibolo River, *For. Bur. 11485 Merritt* (M). PANAY, Capiz Province, Jamindan, *Bur. Sci. 30867 Ramos and Edaño* (M, W, C). NEGROS, Oriental Negros Province, Cuernos Mountains, *Elmer 10108* (M, W).

This plant, which has been most often collected as a scandent epiphyte with pendant sprays, has been collected at altitudes from 600 meters (*Merritt*) to 3,000 meters, on Mount Pulog (*Ramos and Edaño*).

The leaves are fairly uniform in size, shape, and texture; of marginal glands, each leaf bears one on each side, 1 or 2 mm from the base of the blade; the lower surface, however, is very variable, sometimes apparently glabrous, sometimes minutely hirsute, and sometimes bearing what appear to be glandular scales. Lanceolate bracts a few millimeters long may be seen on a few of the specimens; on the other hand, on a few of the specimens, the bracteoles mentioned in the original description are absent. The flowers vary from white to red-purple. The anthers are produced into short tubes; the filaments are pubescent only at the base, which is bulbous rather than flattened. The apparently mature fruits (*Loher 12665*) appear to be black; they are about 4 mm in diameter; the conspicuous calyx forms a belt, rather than a crown, surrounding the upper one-third; the interior is filled with dark brown, fusiform, rugulose seeds about 2 mm long, apparently in ten rows.

The pubescence is extremely variable; the following table presents my observations on all the fertile specimens. It is to be noted that on one sheet (*Bur. Sci. 45021 Ramos and Edaño,* at Manila), two plants of the same collection differ.

Collection.	Pedicel.	Ovary.	Disk.	Style.
Clark	Glabrous	Glabrous	Glabrous	Pubescent.
Bur. Sci. 45021 Ramos and Edaño	do	do	do	Glabrous
	Pubescent	Pubescent	do	do.
Bur. Sci. 40404 Ramos and Edaño	Glabrous	do	(?).	(?).
For. Bur. 29412 Zschokke et al.	Pubescent	do	Pubescent	(?).
Loher 12665	Glabrous	Glabrous	Glabrous	(?).
Loher 14173	do	do	do	Pubescent.
For. Bur. 11485 Merritt	do	do	do	(?).
Bur. Sci. 30867 Ramos and Edaño	do	Pubescent	Pubescent	(?).
Elmer 10108	Pubescent	Glabrous	Glabrous	Pubescent.

It is evident that almost every collection shows distinctive characters. I would expect further collections to show that these characters mark local races, which should be treated as varieties or even as species. For the present, however, as I am able to see no correlations of the characters with each other or with geographic distribution, I think it safer to make no segregation.

15. VACCINIUM PLATYPHYLLUM Merrill.

Vaccinium platyphyllum MERR. in Philip. Journ. Sci. 12 (1917) Bot. 294, Enum. Philip. Fl. Pl. 3 (1923) 251.

Vaccinium ilocanum MERR. in Philip. Journ. Sci. 14 (1919) 441, Enum. Philip. Fl. Pl. 3 (1923) 294.

Vaccinium rizalense MERR. in Philip. Journ. Sci. 27 (1925) 43.

The original description of *Vaccinium platyphyllum* reads:

Frutex vel arbor parva inflorescentiis exceptis glabra; foliis ellipticis ad oblong-ellipticis, usque ad 14 cm longis et 7 cm latis, crasse coriaceis, integris, in siccitate pallidis, nitidis, basi acutis, apice prominente acuminatis, nervis utrinque 4 vel 5, tenuibus, adscendentibus; racemis axillaribus, solitariis, parce pubescentibus, 4 ad 6 cm longis, bracteis oblongo-lanceolatis, acuminatis, circiter 8 mm longis, supersistentibus; corolla circiter 5 mm longa, extus leviter pubescentibus; ovario pubescente; calycibus lobis acutis, 1.2 mm longis, extus pubescentibus.

A shrub or small tree, glabrous except the inflorescence. Branches pale-brownish, terete, smooth, the younger branchlets reddish-brown, somewhat angular, rather stout. Leaves alternate, rather distant, thickly coriaceous, stiff, elliptic to ovate- or oblong-elliptic, 11 to 14 cm long, 5 to 7 cm wide, entire, rather pale when dry, base acute, apex prominently acuminate, the acumen rather broad, 1 to 1.5 cm long; lateral nerves 4 or 5 on each side of the prominent midrib, slender, ascending, mostly leaving the midrib in the lower one-third, obscurely anastomosing, the reticulations not prominent; petioles stout, about 1 cm long. Racemes axillary, solitary, 4 to 6 cm long, sparingly pubescent, the bracts subpersistent, oblong-lanceolate, acuminate, about 8 mm long, black when dry. Pedicels about 7 mm long, slightly pubescent. Corolla 5 mm long, externally sparingly pubescent, narrowed upward, the mouth about 1.5 mm in diameter, the short, broadly ovate, obtuse lobes recurved. Anthers 1.5 mm long. Ovary pubescent. Young fruit cup-shaped, 3 mm long, pubescent, the persistent calyx-teeth triangular-acute, 1.2 mm long.

LUZON, Tayabas Province, vicinity of Dingalan on the Pacific coast, *Bur. Sci. 26583 Ramos & Edaño*, August 25, 1916, on slopes at an altitude of about 200 meters.

This is perhaps as closely allied to *Vaccinium perrigidum* Elm., as to any other described species. It is characterized by its large, faintly and obliquely nerved leaves, and its slightly pubescent racemes.

Of *Vaccinium ilocanum*:

Frutex epiphyticus, inflorescentiis exceptis glaber; foliis ellipticis, crasse coriaceis, nitidis, integris, 6 ad 8 cm longis, basi acutis, apice breviter abrupteque acuminatis, nervis utrinque circiter 4, tenuibus, inferioribus adscendentibus; racemis axillaribus, solitariis, 2 ad 4 cm longis, pubescentibus; bracteis persistentibus, ovatis ad elliptico-ovatis, 5 ad 6 mm longis, acutis vel acuminatis; corolla glabris 6 mm longa; filamentis barbatis; antheris oblongis, 1.1 mm longis.

An epiphytic shrub, entirely glabrous except the inflorescences, the branchlets about 3 mm in diameter, reddish-brown when dry. Leaves elliptic, thickly coriaceous, olivaceous and shining when dry, entire, 6 to 8 cm long, 3.5 to 5 cm wide, margins somewhat recurved, the lower surface somewhat paler than the upper and distinctly glandular-punctate, the base acute, apex acute to shortly and abruptly acuminate; lateral nerves about

4 on each side of the midrib, slender, the lower two pairs from near the base ascending, reaching at least to the upper two-thirds of the leaf; petioles very stout, reddish-brown, 5 to 8 mm long. Racemes axillary, and sometimes terminating short lateral branches, 2 to 4 cm long, the rachis, bracts, pedicels, and calyces more or less pubescent with short spreading hairs; pedicels 3 to 4 mm long; bracts persistent ovate to elliptic-ovate, 5 to 6 mm long, usually acute, sometimes slightly acuminate. Calyx-tube almost obsolete, the lobes triangular, acute, pubescent, 1.5 mm long. Corolla oblong-ovoid, glabrous, narrowed upward, about 6 mm long, 3.5 mm in diameter below the middle, red, the lobes short, broadly ovate, recurved. Filaments densely bearded, about 1 mm long; anthers oblong, about 1.1 mm long, the terminal tubes very short, not narrowed, opening by oblique pairs [pores]. Style stout, glabrous, 3 mm long. Top of the ovary very slightly pubescent.

LUZON, Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33372 Ramos*, August 21, 1918, growing on trees on forested slopes near the summit, altitude about 3,100 meters [3,500 feet, according to Ramos, on the field label].

The alliance of this species is manifestly with *Vaccinium platyphyllum* Merr., from which, among other characters, it is distinguished by its smaller, fewer-nerved leaves, shorter pedicels, and only slightly pubescent top of the ovary.

Of *Vaccinium rizalense:*

Arbor parva, inflorescentiis exceptis glabra; foliis crasse coriaceis, ellipticis vel oblongo-ellipticis, 6 ad 9 cm longis, breviter acuminatis, basi acutis, in siccitate supra olivaceis vel pallide olivaceis, subtus brunneis, nervis utrinque 2 vel 3, tenuibus, adscendentibus; racemis axillaribus, leviter pubescentibus, solitariis vel fasciculatis, 4 ad 8 cm longis, bracteis subpersistentibus, oblongis, subacutis, leviter pubescentibus, 8 mm longis; floribus ovoideis, 5 mm longis, extus leviter adpresse pubescentibus, corolla sursum contracta, lobis ovatis, reflexis, 1 mm longis; filamentis 1.5 mm longis, leviter ciliatis, antheris oblongis, apice breviter productis, filamentis subaequantibus; ovario pubescente, stylis cylindricis, glabris, 4 mm longis.

A tree, glabrous except the sparingly pubescent inflorescences, the branches rugose, dark reddish brown. Leaves thickly coriaceous, elliptic to oblong-elliptic, 6 to 9 cm long, 3 to 4.5 cm wide, the apex shortly and bluntly acuminate, the base acute, margins somewhat reflexed, the upper surface olivaceous or pale olivaceous when dry, the lower surface brown, somewhat glandular-punctate; lateral nerves 2 or 3 on each side of the midrib, slender, ascending, reticulations obscure; petioles stout, 1 cm long or less. Racemes axillary, solitary or fascicled, 4 to 8 cm long, many-flowered, slightly appressed-pubescent, the bracts oblong, subpersistent, about 8 mm long, 3.5 mm wide, acute or slightly acuminate, the bracteoles acuminate, 2 mm long. Flowers purple, externally slightly appressed-pubescent, 5 mm long, their pedicels 2.5 to 4 mm long. Calyx somewhat pubescent, the tube very short, the lobes triangular, acute, 1.2 mm long. Corolla ovoid, inflated below and nearly 3 mm in diameter, contracted above and 1 to 1.2 mm in diameter at the apex, the lobes broadly ovate, subacute, reflexed, 1 mm long. Filaments thickened below, somewhat

pubescent, 1.5 mm long, the anthers oblong, equaling the filaments, slightly produced at their apices. Ovary pubescent; style cylindric, glabrous, 4 mm long.

LUZON, Rizal Province, Guinuisan and Balacbac, *Loher 12150, 14979* (type), June and July, 1909 and 1912.

A species closely allied to *Vaccinium platyphyllum* Merr., differing in its much smaller leaves.

LUZON, Tayabas Province, Dingalan, *Bur. Sci. 26583 Ramos and Edaño* (M, W): Ilocos Norte Province, Mount Palimlim, *Bur. Sci. 33372 Ramos* (M, W): Rizal Province, Guinuisan, *Loher 12150* (M, C); Balacbac, *Loher 14979* (M, C).

I have here reduced to one, three species, of which one was represented by two collections and each of the others by one. The type is not a very good specimen, and leaves me in doubt at some points; as far as can be determined, the collections differ only in habit, size of leaves, and length of inflorescences. All of them have coriaceous, ovate, acuminate leaves, veiny and minutely lepidote beneath, each with a rather large gland on each side of the blade close to the base. The inflorescences are bracteate and bracteolate; the peduncles, bracts, pedicels, bracteoles, ovaries, calyx lobes, and corollas (not seen in the type) are more or less pubescent. The pubescent disk is decidedly bulkier than the ovary; the style glabrous. The stamens (not seen in the type) are as described under *V. rizalense;* the oblong anthers, equaling the bearded filaments, are without horns and have very short tubes. The fruit is unknown.

16. VACCINIUM IRIGAENSE Merrill.

Vaccinium irigaense MERR. in Philip. Journ. Sci. 10 (1915) Bot. 52, Enum. Philip. Fl. Pl. 3 (1923) 249.

The original description reads as follows:

Frutex glaber, circiter 5 m altus; foliis usque ad 6 cm longis, coriaceis, oblongo-obovatis, petiolatis, utrinque angustatis, basi acutis, tenuiter 5- vel 7-plinerviis, apice subrostrato-acuminatis; racemis axillaribus, solitariis, usque ad 6 cm longis, multifloris; floribus 1 cm longis, oblongis, sursum angustatis, ebracteolatis; filamentis pilosis.

A glabrous shrub about 5 m high, the branches dark reddish-brown, terete, shining, the branchlets brownish. Leaves coriaceous, rather narrowly oblong-obovate, 4.5 to 6 cm long, 1.5 to 2.5 cm wide, shining, the lower surface paler than the upper, narrowed below to the acute and slenderly 5- or 7-plinerved base, and above to the somewhat rostrate-acuminate apex, the acumen blunt, less than 1 cm long; reticulations slender, lax; petioles 5 mm long or less. Racemes axillary, solitary up to 6 cm long, rather many flowered. Flowers red, 1 cm long, their pedicels 6 to 7 mm long, ebracteate. Calyx glabrous, about 1.5 mm long, 3 to 3.5 mm in diameter, the lobes broadly ovate, blunt, 1 mm long or

less. Corolla oblong, 3 mm in diameter below, narrowed above and 1 mm in diameter under the orifice, glabrous, the lobes slightly spreading, oblong, obtuse, 1 mm long. Stamens 10; the filaments flattened below, somewhat pilose, 4 mm long; anthers oblong, truncate, straight or slightly curved, 1.5 mm long. Style stout, glabrous, 8 mm long.

LUZON, Province of Camarines, Mount Iriga, *Phil. Pl. 1549 Ramos*, December 3, 1913, in the mossy forest.

A species manifestly allied to *Vaccinium caudatum* Warb., from which it differs in its quite differently shaped leaves and larger flowers.

LUZON, Camarines Sur Province, Mount Iriga, *Philip. Pl. 1549 Ramos* (M, type): Sorsogon Province, Mount Bulusan, *Bur. Sci. 23676 Ramos* (M, W), *Elmer 16867* (M, W, C; distributed as *Vaccinium jagori*); Mount Poidol, *Bur. Sci. 23361 Ramos* (M, W). CATANDUANES, Mount Mariguidon, *Ramos and Chan* (M).

This is a sharply distinct species of limited distribution, in and near southern Luzon, mostly at rather low altitudes. The description calls for the following comments: The leaves, oblanceolate, at the base tapering insensibly into the brief petiole and at the apex abruptly acuminate, bear on each margin near the base one or two inconspicuous glands; the lower surface shows, under the lens, no glands. These leaves alone distinguish the species from all others in the Philippines. The corolla is not exactly urceolate, being abruptly contracted near the summit. The stamens resemble those of *Vaccinium whitfordii* and *V. sylvaticum;* the anthers lack horns and tubes, and the oblique pores gape widely. The disk is about as bulky as the ovary. The ovary, calyx, and disk are glabrous, except that the calyx lobes are ciliate. The immature fruits, seen on all the specimens except the type, are spherical, about 6 mm in diameter, conspicuously crowned by the disk and erect calyx lobes; they contain five cells, V-shaped in cross section.

SUBSECTION 6. ALLIES OF VACCINIUM HALCONENSE

Leaves of variable size and shape, mostly with a glandular lower surface; mostly with only one or two pairs of marginal glands. Racemes with minute bracts or none. Corolla more or less tubular. Anthers mostly with horns. Disk pubescent, less bulky than the ovary.

This series, which is apparently derived from Subsection 1, is represented in Borneo by *V. pachydermum* Stapf and *V. clementis* Merrill; the former with fairly large, obovate, rounded leaves, and pubescent pedicels, rachises, and ovaries; the latter differing in having smaller leaves and glabrous ovaries. *Vaccinium camiguinense* is very close to *V. pachydermum.* From

something between *V. pachydermum* and *V. clementis,* one may derive *V. halconense* and *V. foxworthyi,* both with pubescent ovaries, the former with large leaves, the latter with small. From the latter, through *V. palawanense,* one may derive *V. vidalii* and *V. cumingianum.* We have here an evident chain of relationship which appears to show the loss of pubescence from the ovary and of horns from the anthers, and the appearance of glands along the margins of the leaves.

17. VACCINIUM CAMIGUINENSE Merrill.

Vaccinium camiguinense MERR. in Philip. Journ. Sci. 7 (1912) Bot. 321, Enum. Philip. Fl. Pl. 3 (1923) 248.

The original description reads:

Species V. jagori Warb. affinis et similimis, differt foliis obtusis vel rotundatis, vix acuminatis vel apiculatis, calycis lobis ciliatis.

A species very similar to and apparently closely allied to *Vaccinium jagori* Warb. A small glabrous tree, the branches terete, olivaceous or brownish, smooth. Leaves thickly coriaceous, subsessile, oblong-obovate to narrowly oblong-obovate, 3.5 to 8 cm long, 1.5 to 8 cm wide, somewhat brownish when dry, shining, the lower surface a little paler than the upper one, somewhat glandular, the apex rounded or obtuse, base narrowed to the very short petiole, subacute or abruptly obtuse, margins slightly recurved; midrid prominent, the lateral nerves sharply ascending, slender, obscure, 2 or 3 basal pairs and one or two additional pairs leaving the midrib below the middle; petioles stout, very short or none. Flowers unknown. Racemes axillary, solitary, 5 to 6 cm long, glabrous. Nearly mature fruits subglobose, glabrous, about 5 mm in diameter, their pedicels 5 to 10 mm long, 10 to 20 in a raceme. Persistent calyx lobes triangular-ovate, acute or somewhat acuminate, 2 mm long, their margins above distinctly ciliate.

CAMIGUIN DE MINDANAO, *Bur. Sci. 14622* (type), *14680 Ramos,* April 9, 1912, in forests near the summit of Mount Mahinog.

A species similar to and manifestly allied to *Vaccinium jagori* Warb., from which it differs chiefly in its obtuse or rounded, not acuminate or apiculate leaves. Among the extra-Philippine species it appears to be allied to *Vaccinium bancanum* Miq., from which it also differs in its vegetative characters.

This species is known only by the specimens originally cited. Flowers are accordingly unknown. The disk is apparently less bulky than the ovary; both the disk and the base of the style are pubescent.

18. VACCINIUM HALCONENSE Merrill.

Vaccinium halconense MERR. in Philip. Journ. Sci. 2 (1907) Bot. 294, 3 (1908) Bot. 377, Enum. Philip. Fl. Pl. 3 (1923) 249.

The original description reads:

Scandens, epiphyticum; foliis oblongo-elliptico-ovatis vel obovatis, acutis vel breviter acuminatis, basi acutis, 6 ad 9 cm. longis, coriaceis; racemis axillaribus, rhachidibus pedicellis fructibusque ferrugineo-pilosis.

A scandent shrub or subarborescent, 5 to 10 m. high, epiphytic or pseudoepiphytic. Branches reddish brown, glabrous, terete, the growing tips slightly pubescent. Leaves coriaceous, oblong-elliptical-ovate or somewhat obovate, 6 to 9 cm long, 2 to 3.5 cm. wide, glandular-punctate beneath and paler than above, slightly shining, the base acute, the apex acute or shortly acuminate; nerves about 3 on each side of the midrib, mostly basal, ascending, not very distinct; petioles stout, 5 mm. long or less, glabrous or slightly pubescent. Racemes axillary, 5 to 7 cm. long, the rachis, pedicels and fruits ferruginous-pilose but not densely so; pedicels about 1 cm. long. Fruits globose, about 8 mm. in diameter.

On exposed ridges [on Mount Halcon], epiphytic on *Podocarpus*, at 1,359 m. alt. (No. 5665); also collected by *Merritt* in June, 1906, at 1,600 m. alt. (No. 4422).

A species distinguishable from all other Philippine representatives of the genus known to me by its pilose racemes and fruits.

LUZON, Zambales Province, Mount Tapulao, *Bur. Sci. 4697 Ramos* (M, W), *For. Bur. 8101 Curran and Merritt* (M); Mount Pinatubo, *Clemens 17469* (C): Bataan Province, Mount Mariveles, *Merrill 781* (M, W). MINDORO, Mount Halcon, *Merrill 5665* (M, W, type), *For. Bur. 4422 Merritt* (M). NEGROS, Occidental Negros Province, Mount Mapara, *For. Bur. 13626 Curran and Foxworthy* (M); Canlaon Volcano, *For. Bur. 17392 Curran* (M, W): Oriental Negros Province, Cuernos Mountains, *Elmer 9541, 9655* (M). MINDANAO, Bukidnon Province, Tangkulan and vicinity, *Bur. Sci. 26065 Fenix* (M, W), *Bur. Sci. 39122 Ramos and Edaño* (M, W).

A woody plant, 3 to 15 meters high, apparently usually terrestrial; all the collections are from altitudes between 1,200 and 1,800 meters.

The large leaves, obtuse or acute, scarcely ever acuminate, punctate beneath, bear on each side near the base one or sometimes two marginal glands. The rachises, pedicels, and fruits are yellow-pubescent. Only the collection from Canlaon Volcano shows the flowers satisfactorily; these are white, according to the field label. Pubescent bracts about 2 mm long may sometimes be found, but are more often absent; bracteoles are absent. The subglobular ovary is about 2 mm in diameter; this and the five spreading acuminate 2-mm-long calyx lobes are densely pubescent (except in the specimens from Bukidnon).

The narrowly campanulate corolla is glabrous, 5 mm long, with five erect or spreading lobes 1 mm long. The stamens are 10 in number; the pubescent filaments are about 2 mm long, attached to the anther near the base of the back; the anthers are about 2 mm long with very minute upcurving horns on the back, and terminate in slender tubes, curved inward and upward, whose length is about one-third the total length of the anther. The disk is prominent, about one-half as bulky as the ovary, pubescent; the style is pubescent, about as long as the corolla, bearing a slightly swollen stigma. The fruit is generally somewhat rugose; the persistent calyx-lobes folded over the disk form a conical crown about 3 mm in diameter. The fruit is 5-celled, with each cell divided by an incomplete partition; the seeds, in 10 rows, are red-brown, irregularly polyhedral, elongate, minutely striate, 1.5 mm long.

19. VACCINIUM FOXWORTHYI sp. nov.

Frutex 1 ad 2 m altus. Folia oblanceolata ad late elliptica, basi cuneata, apice obtusa, subtus punctata, 2.5 ad 4.5 cm longa, c. 1.5 cm lata, marginibus recurvis integris glandula una utrinque basi excepta, venatio reticulato manifesto. Racemi c. 10-flori, 2 ad 3 cm longi, rhachide puberulente, pedicellis 5 mm longis puberulentibus. Ovarium hemisphaericum puberulente, calycis lobis 5, ovatis, obtusis, puberulentibus. Corolla tubulosa, alba vel rosea, in sicco fusca, glabra, c. 6 mm longa, lobis 5 brevibus, obtusis. Stamina 10, c. 3 mm longa, filamentis pubescentibus, antherae ovoidei, 1 mm longae, ad basim tubulorum brevissimorum geniculatae, dorso minutissime biaristatae. Discus prominens, quam ovario minor, medio puberulens, stylo 6 mm longo, puberulente. Fructus (juvenilis) pubescens, disco calyceque coronatus, lobis calycis erectis, 5 mm diametro, 5-locularis, loculo quoque spurie subbipartito; semina fulva, fusiformia, 1 mm longa.

PALAWAN, Mount Victoria, *Bur. Sci. 649 Foxworthy* (M, W, type); Mount Capoas, *Merrill 9526* (M, W).

The type collection was made at 1,700 meters, and has oblanceolate leaves; Merrill's collection was made at 1,000 meters, and has elliptic leaves. According to the field notes attached to both collections, the plant forms a dense shrubby growth and is the dominant species on ridges at and near summits. This species is very close to *Vaccinium halconense,* differing in the smaller leaves and lower stature, and in the stamens, which resemble those of *Vaccinium elegans;* it is also close to *Vaccinium palawanense,* from which it differs in the pubescent ovary.

20. VACCINIUM PALAWANENSE Merrill.

Vaccinium palawanense MERR. in Philip. Journ. Sci. 3 (1908) Bot. 373, Enum. Philip. Fl. Pl. 3 (1923) 251; ELMER in Leafl. Philip. Bot. 3 (1911) 1099.

The original description reads:

Arbor parva usque ad 6 m alta, inflorescentia excepta glabra; foliis late oblanceolatis vel elongato-elliptico-oblanceolatis, coriaceis, nitidis, circiter 5 cm longis, basi cuneatis, apice breviter obtuse acuminatis, marginibus revolutis, integris; racemis axillaribus, folia aequantibus, sparse pubescentibus; floribus circiter 8 mm longis; corolla tubulari, medio plus minus inflata, ore viz contracta; staminibus 10; antheris dorso 2-aristatis, appendicibus tubulosis, circiter 0.5 mm longis, poris orbicularibus dehiscentibus.

A small tree or shrub reaching a height of about 6 m, the trunk 12 cm in diameter, glabrous except the inflorescence. Branches terete, glabrous, grayish, the branchlets somewhat angled. Leaves broadly oblanceolate or oblong-elliptical-oblanceolate, about 5 cm long, 1 to 1.8 cm wide, coriaceous, brownish when dry, glabrous, the upper surface shining, the lower dull and somewhat glandular-punctate, the apex shortly and obtusely acuminate, the base gradually narrowed, cuneate, the margins entire, rather strongly recurved; lateral nerves 2 or 3 on each side of the midrib, not distinct, ascending, the reticulations nearly obsolete; petioles stout, about 2 mm long. Racemes axillary, solitary, about as long as the leaves, somewhat pubescent, each with from 6 to 14 flowers. Flowers white to light pink, fragrant, their pedicels 5 to 7 mm long, articulated with the calyx. Calyx tube subglobose, 2 mm long, the lobes 5, ovate, acute, about 1.4 mm long, their margins slightly ciliate. Corolla tubular, about 8 mm long, 3 mm in diameter, somewhat swollen at about the middle, the mouth not contracted; lobes 5, erect, broadly triangular-ovate, somewhat auricled at the base, less than 1 mm long. Stamens 10, inserted on the base of the corolla; filaments nearly 3 mm long, lanate; anthers 1.5 mm long, the dorsal awns two, erect, slender, curved, about 0.8 mm long, the apical tubes cylindrical, about 0.5 mm long, opening by terminal pores. Disk glabrous, tumid; style 7 to 8 mm long, slightly pubescent; ovary 5-celled.

PALAWAN, Mount Victoria, *Bur. Sci. 696 Foxworthy*, March 23, 1906, on rocky slopes along streams at an altitude of about 1,000 m. A form of the same species is apparently represented by *Bur. Sci. 649 Foxworthy*, same locality, but from an altitude of 1,750 m, a shrub 1.5 to 2 m high on exposed ridges, which differs from the type in having somewhat more pubescent racemes and shorter dorsal horns on the anthers.

A species with much the appearance of *Vaccinium banksii* Merr., but differing in many characters, notably in the presence of dorsal awns on the anthers, these being absent in *V. banksii.*

Elmer's remarks on this species are as follows:

Field note for 11470:—Epiphytic shrub, 10 feet high, on the main branches of lofty trees, or terrestrial and treelike in humid woods of low moist flats at 6,250 feet and in the shrubberies at a higher elevation on mount Apo; stem ascendingly branched, rigid; wood rather hard, whitish, closely grained, without odor or taste; bark brown, longitudinally

checked, greenish black and smooth on the branches; leaves rigidly coriaceous, ascending, slightly recurved, very deep dull green or shining above, only shallowly conduplicate, much lighter or even yellowish green beneath, the young leaves reddish; rachis green or reddish on the upper exposed side; pedicels recurved, light green; calyx similar in color, the segments the color of the corolla which is of a very pretty waxy red; style and filaments whitish, anthers yellowish brown. This the Bagobos call "Cayaupang."

Represented by numbers 11470, 11390 and 11252, *Elmer*, Todaya (Mt. Apo), Mindanao, August, 1909.

All of these specimens vary somewhat from one another and none is typical of the type specimen collected by *Dr. Foxworthy* on Mount Victoria of Palawan.

PALAWAN, Mount Victoria, *Bur. Sci. 696 Foxworthy* (M, W); Mount Pulgar, *Elmer 13202* (M, W). MINDANAO, Davao Province, Mount Apo, *Mearns s. n.* (W, two sheets), *Elmer 11252, 11390* (M, W), *Elmer 11470* (M).

I have made *Bur. Sci. 649 Foxworthy,* mentioned in the original description of *Vaccinium palawanense,* the type of *Vaccinium foxworthyi,* a new species.

The specimens here cited as *Vaccinium palawanense* vary in the size of the leaves, those of the specimens from Mount Apo being larger; furthermore, some of the latter have broad flattened petioles 6 mm long. The mature leaves are punctate beneath; this is not usually evident on the young ones, which usually bear a few scattered glandular hairs. The reticulate venation is prominent on the mature leaves. Of marginal glands, one or two basal pairs are evident; others, if present, have not been detected. There are no bracts or bracteoles; the rachises and pedicels are puberulent; the ovary is glabrous, the calyx lobes ciliate; the disk is pubescent in the center, the style pubescent at the base; the fruits (definitely mature examples not seen) resemble those of *Vaccinium halconense* and *Vaccinium camiguinense,* to which species this one is closely related.

21. VACCINIUM VIDALII Merrill and Rolfe.

Vaccinium vidalii MERR. and ROLFE in Philip. Journ. Sci. 3 (1908) Bot. 374; MERR., Enum. Philip. Fl. Pl. 3 (1923) 252.

The original description reads:

Arbuscula subglabra 2.5 ad 4 m alta; foliis oblongo-ovatis, elliptico-ovatis, vel oblongo-lanceolatis, coriaceis, nitidis, supra glabris, subtus glabris vel in costa sparse pilosis, 2.5 ad 3 cm longis, basi acutis, apice obtuse acuminatis; racemis axillaribus, folia aequantibus vel superantibus, paucifloris; floribus longe pedicellatis; corolla cylindraceo-urceolata, circiter 4 mm longa; staminibus 10; antheris productis, poris apicaliter dehiscentibus, dorso aristatis.

A nearly glabrous shrub 2.5 to 4 m high. Branches and branchlets glabrous, terete, gray or reddish brown. Leaves alternate, coriaceous, oblong-ovate, elliptical-ovate or oblong-lanceolate, 2.5 to 3 cm long, 0.8 to 1.5 cm wide, the upper surface glabrous, very shiny, the lower surface dull or shining, glabrous, or the midrib slightly pilose, the base acute, the apex shortly and obtusely acuminate, the margins entire, usually with rather prominent marginal glands simulating teeth; nerves nearly obsolete, the reticulations entirely so; petioles 2 mm long or less, sometimes slightly pubescent. Racemes axillary, solitary, 5 cm long or less, glabrous, each with from two to six long-pedicelled flowers, the pedicels 1 to 1.5 cm long. Calyx-tube broadly ovoid, the teeth 5, small. Corolla cylindrical-urceolate, about 4 mm long, 3 to 3.5 mm in diameter, slightly contracted above, the lobes 5, ovate, acute, reflexed, about 1 mm long. Stamens 10; filaments lanate, attenuate above; anthers 2 mm long, each with two, slender, 0.6 mm long awns on the back, the apical tubes nearly 1 mm long, opening by slightly oblique, orbicular pores. Disk prominent, densely pubescent. Style 3 mm long, glabrous. Fruit globose, 4 mm in diameter, glabrous except the persistent pubescent annulus.

LUZON, Province of Zambales, Mount Tapulao, *For. Bur. 8256 Curran & Merritt,* December, 1907; *Bur. Sci. 4765, 5132 Ramos,* same date.

A species growing on exposed ridge-forests at an altitude of about 1,400 m, epiphytic or pseudo-epiphytic, having the strangling habit of most species of *Ficus* of the section *Urostigma.* It has also been collected by Vidal in the Caraballo Mountains, Province of Nueva Ecija, Luzon, No. 3144 in Herb. Kew.

In many respects the present species resembles *Vaccinium cumingianum* Vidal, but differs especially in its relatively broader leaves, different flowers and lax racemes.

LUZON, Zambales Province, Mount Tapulao, *For. Bur. 8256 Curran and Merritt* (M, W), *Bur. Sci. 4765 Ramos* (M, W), *Bur. Sci. 5132 Ramos* (M), *Loher s. n.* (M): Nueva Ecija Province, Carballo Mountains, *Vidal 3144* (M, fragm. ex herb. Kew): Rizal Province, *Loher 12245* (C); Montalban, *Loher 12755* (C), *Loher 12936* (M, C); Mount Lumutan, *Bur. Sci. 29618 Ramos and Edaño* (M, W); Mount Tokduanbanoy, *Bur. Sci. 45878 Ramos and Edaño.*

Most of the collectors have failed to mention on the field notes any strangling habit. A shrub 2.5 to 5 meters high; altitude 300 to 2,000 meters; flowers white, so far as recorded, probably also red.

The leaves have glands all along the margins, and are usually glandular-punctate beneath. The ovary is glabrous; the calyx teeth are ciliate; the densely pubescent disk is consistently less bulky than the ovary. The fruit is 5-celled, each cell being subdivided by an incomplete partition; the brown seeds are about 1 mm long.

This species is so close to some varieties of *Vaccinium cumingianum,* which occur in the same localities, as to be indistinguishable, except when in flower, when the horns on the anthers can be seen.

22. VACCINIUM CUMINGIANUM Vidal.

Vaccinium cumingianum VIDAL, Rev. Pl. Vasc. Filip. (1886) 167; MERR. in Philip. Journ. Sci. 1 (1906) Suppl. 112, 3 (1908) Bot. 375, Enum. Philip. Fl. Pl. 3 (1923) 248.

Vaccinium microphyllum F.-VILL., Noviss. App. (1880) 121, in part, non Reinw.

Vaccinium sp. (aff. *V. coriaceo*) VIDAL, Sinopsis Atlas (1883) 30, t. 60, f. C.

Vaccinium sp.—VIDAL, Phan. Cum. Philip. (1885) 21, 123.

The original description reads:

Frutex vel fruticulus; ramulis striatis, sub-angulatis, glabris, griseis. Folia brevissime petiolata, oblonga aut lineari-oblonga, utrinque angustata, apice obtuso sæpissime calloso, longa 2-3 cm. lata 5-10 mm., margine integerrima vel sub-dentato-callosa, revoluta, supra in sicco sæpius nigricantia vel fusco-maculata, subtus ferruginea; nervatura et inflorescentia *V. Villarii* simillima. Flores ignoti. Fructus globosus, areolatus ad 5 mm. diam., cæruleo-nigricans.

Synom.—V. sp. (aff. *V. coriaceo,* Miq.), Vid. Sinops. t. 60 f. C.; *V. microphyllum,* F.-Vill., non Reinw., l. c. in parte.

413 Monte Banahao, 2.000^{m}. alt., Pr. Tayabas—Cum. 805 Pr. Tayabas.

This species, as I construe it, is very variable. The leaves are nearly always less than 4 cm long; they may be ovate, elliptic, or lanceolate, acuminate. The racemes are very variable in length; the rachises and pedicels glabrous; the calyx teeth variable; the corolla is about as in *Vaccinium vidalii,* but more slender, white, pink, or red; the filaments are pubescent; the anthers without horns, split into slender tubes for about half their length, with terminal oblique suborbicular pores; the disk is very pubescent, consistently less bulky than the ovary; the style glabrous.

The following is a key to the varieties:

1. Calyx lobes well developed.
   2. Leaves ovate, 1.5 to 2 cm long, glandular all along the margins. var. *pyriforme.*
   2. Leaves narrowly elliptic, 2.5 to 4 cm long, margins glandular only near the base .... var. *marivelesense.*
1. Calyx lobes obscure or obsolete; leaves 2.5 to 3.5 cm long.
   2. Leaf margins glandular only at the base.
      3. Leaves narrowly elliptic .... typical *V. cumingianum.*
      3. Leaves more or less lanceolate, acuminate .... var. *tayabasense.*
   2. Leaves glandular all along the margins .... var. *igorotorum.*

Typical VACCINIUM CUMINGIANUM.

LUZON, on the boundary between Laguna and Tayabas Provinces, Mount Banahao, *Cuming 805* (M), *For. Bur. 878 Klemme* (M), *Whitford 963* (M, W), *For. Bur. 7882, 7889, 7893 Curran and Merritt* (M), *Bur. Sci. 6560 Robinson* (M), *Bur. Sci. 19580 Ramos* (M, W, C); Lukban Cone, *Elmer 7788* (M), *Elmer 9212* (M, W); Mount San Cristobal, *Copeland s. n.* (M).

These specimens represent shrubs or trees from 1 to 7 meters high, the leaves narrowly elliptic, cuneate, obtuse, 1.5 to 3 cm long, with marginal glands confined to the basal part; rachises 1 to 2 cm long; pedicels 2 to 7 mm long; calyx lobes subobsolete; filaments about 2 mm long, the anthers of about the same length.

Altitude about 2,000 meters. I am treating as typical of the species only the specimens from the Banahao group of mountains, although some of the specimens listed under the first two among the following varieties might almost as well be listed here.

Var. TAYABASENSE var. nov.

Arbor vel frutex, 2 ad 7 m altus; foliis lanceolatis, cuneatis, acuminatis, glandulis marginalibus paucis prope basim; rhachidibus 1 ad 4 cm, pedicellis 2 ad 12 mm, longis; calycis lobis subobsoletis; antheris 2 ad 3 mm longis; filamentis subaequantibus.

LUZON, Laguna Province, Mount Banahao, *Bur. Sci. 75052 Rivera and Duyag* (C): Tayabas Province, Mount Calvario, *For. Bur. 30060 Sulit* (C): Batangas Province, Lobo Mountains, *For. Bur. 28049 Mabesa* (M, C, type of the variety): Rizal Province *Loher s. n.* (C); Montalban, *Loher 12305* (M, C), *Loher 12152, 12162* (C).

There is great variation in the length of the rachises and pedicels; furthermore, these specimens were collected at altitudes ranging from 600 to 2,000 meters. It is accordingly not certain that this is a natural group. It is known by specimens collected in flower that races of small-leaved *vacciniums* both with and without horns on the anthers occur in Rizal and Zambales Provinces. Those with horns belong to *Vaccinium vidalii;* those without I have assigned partly to this variety and partly to the next. The identification of specimens coming from those regions and lacking flowers is very difficult. I have assigned specimens with glands all along the edges of the leaves to *Vaccinium vidalii,* and others to this and the next variety of *Vaccinium cumingianum.*

Var. MARIVELESENSE var. nov.

Arbor vel frutex 2 ad 8 m altus; folia anguste elliptica, cuneata, acuta, usque ad 4 cm longa, glandulis marginalibus paucis prope basim; rhachis 5 ad 20 mm longa, saepius brevis, pedicellis 5 ad 12 mm longis; calycis lobi manifesti; antherae c. 2 mm longi; filamentis subaequantes.

LUZON, Bataan Province, Mount Mariveles, *For. Bur. 1330, 1585 Borden* (M, W), *For. Bur. 2649 Meyer* (M, W), *Whitford 245, 459* (M, W, type of the variety); *Merrill, Decades 281* (M, C, S), *Merrill 729* (M, W): Zambales Province, Mount Pinatubo, *Bur. Sci. 2535 Foxworthy* (M, W), *Clemens 17470* (C): Pampanga Province, Mount Abu, *Bur. Sci. 1911 Foxworthy* (M, W).

Altitude 1,000 to 2,000 meters. These specimens appear to represent a very uniform race.

Var. IGOROTORUM var. nov.

Arbor vel frutex 3 ad 15 m altus; folia anguste elliptica, cuneata, acuta, usque ad 4 cm longa, marginibus distante glandulosis per totam longitudinem; rhachidibus 5 ad 20 mm longis, pedicellis 2 ad 10 mm longis, saepius brevibus; calycis lobis subobsoletis; antheris c. 2 mm longis; filamentis subaequantibus.

LUZON, Mountain Province, Benguet Subprovince, *Loher 5077* (M, W), *Clemens 17216* (C); Mount Santo Tomas, *Elmer 5804* (M, W, type of the variety), *Merrill 4817* (M, W), *For. Bur. 14421 Darling* (M); Baguio, *Bur. Sci. 5712 Ramos* (M), *For. Bur. 18001 Merritt* (M); Lusud-Bayabas trail, *For. Bur. 10844 Curran* (M); Mount Baudan, *Bur. Sci. 40310 Ramos and Edaño* (M, C); Pauai, *Bur. Sci. 4404 Mearns* (M), *For. Bur. 18637 Alvarez* (M), *Bur. Sci. 31919 Santos* (M): Lepanto Subprovince, Bauco, *Vanoverbergh 1232* (M); Mount Sinapsapan, *Bur. Sci. 40457 Ramos and Edaño* (M): Bontoc Subprovince, Mount Pukis, *Bur. Sci. 37737 Ramos and Edaño* (M): Mountain or Nueva Vizcaya Province, *For. Bur. 15827 Curran and Merritt* (M).

Altitude from 1,500 to more than 2,000 meters. A fairly uniform race.

Var. PYRIFORME (Merr.) comb. nov.

Vaccinium pyriforme MERR. in Philip. Journ. Sci. 2 (1907) Bot. 295, 3 (1908) Bot. 373, Enum. Philip. Fl. Pl. 3 (1923) 251.

The original description reads:

Epiphyticum, glabrum, scandens; foliis elliptico-oblongis vel anguste elliptico-obovatis, integris, obtusis, 1.5 ad 2 cm. longis, ad 5 mm. latis, glabris, coriaceis; racemis axillaribus, paucifloribus, 1.5 cm. longis; fructibus pyriformibus.

A slender scandent epiphyte, glabrous throughout. Stems slender, reddish brown, angular. Leaves elliptical-oblong or narrowly elliptical-obovate, the apex obtuse, the base acute, 1.5 to 2 cm. long, about 5 mm. wide, coriaceous, shining, pale when dry, entire, the nerves few, indistinct; petioles 1 to 2 mm. long. Racemes axillary, few flowered, 1.5 cm. long, the rachis about 1 cm. long, the pedicels 5 mm. long. Flowers unknown. Fruit pyriform, glabrous, about 4 mm. long, the apex subtruncate and somewhat pubescent inside the persistent obscure calyx teeth.

Epiphytic in forests at 1,600 m. alt. (No. *4424 Merritt*) June, 1906. A species characterized by its small entire leaves, axillary racemes and pyriform fruit.

MINDORO, Mount Halcon, *For. Bur. 4424 Merritt* (M, type). PANAY, Capiz Province, Mount Bulilao, *Bur. Sci. 35714 Martelino and Edaño* (M, W, C). LUZON, Albay Province, Mount Mayon, *Bur. Sci. 6501 Robinson* (M): Camarines Norte or Camarines Sur Province, exact locality illegible, *For. Bur. 21689 Miranda* (M).

These specimens, aside from the type, represent terrestrial plants 1 to 4 meters high, from altitudes of 1,000 meters, more or less; they agree with the type in having small obtuse leaves with glands at intervals all along the margins (not mentioned in the original description), short racemes, pedicels of moderate length, and evident calyx teeth. The collection from Capiz, the only one in flower, shows a tubular-campanulate corolla about 4 mm long and anthers and filaments each about 1.5 mm long. I have reduced *Vaccinium pyriforme* to the rank of a variety in the idea that the habit and the shape of the fruits, the latter being manifestly immature, of the type specimen, do not distinguish it from the more-revealing material from Capiz; while the latter evidently represents a race of *Vaccinium cumingianum.*

Specimens of VACCINIUM CUMINGIANUM not assigned to any variety.

LUZON, Tayabas Province, Umiray, *Loher 14016* (M, C): Rizal Province, Mabiluang, *Loher 14461* (M, C); Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26503, 26440 Ramos and Edaño* (M, W). The above collections are indistinguishable from the typical form, but are geographically incongruous.

LUZON, Abra Province, Mount Paraga, *Bur. Sci. 7223 Ramos* (M). This sterile specimen has all the appearance of variety *pyriforme,* but is geographically incongruous.

LUZON, Tayabas Province, Mount Alzapan, *Bur. Sci. 45668 Ramos and Edaño* (M). This fruiting specimen appears to represent an undescribed variety. The oblanceolate-acuminate leaves are about 5 cm long, with glands along the basal halves

of the margins; the fruits mark the plant as some form of *Vaccinium cumingianum*, and show that the calyx teeth are evident.

SUBSECTION 7. ALLIES OF VACCINIUM JAGORI

Leaves mostly small, elliptic, with glandular margins; racemes without bracts; pedicels inclined to be short and stout; anthers without tubes and horns; disk as bulky as the ovary or more so.

Of the five species included in this subsection, *V. jagori* is the best known. This species resembles, in some respects, the Javan species *V. varingiaefolium* and *V. lucidum;* I cannot, however, convince myself that a close relationship exists. The chief differences are the lack of bracts on the racemes of *V. jagori*, and the glandular margins of the leaves.

The circles of relationship of *V. luzoniense* and *V. perrigidum* include species with bulky, often glabrous, disks, and anthers with more or less reduced horns and tubes. I am inclined to the opinion that *V. banksii*, *V. woodianum*, and *V. jagori* form a strictly Philippine series closely related to Subsection 5.

Vaccinium sylvaticum, with larger leaves than the other species, is included in this subsection with doubt. *Vaccinium whitfordii* shows all the characters common to the other species of *Nesococcus*, except that the flowers are solitary in the axils of leaves. Being included in this section, this species seems to be closer to the present subsection than to the others.

23. VACCINIUM SYLVATICUM Elmer.

Vaccinium sylvaticum ELMER in Leafl. Philip. Bot. **3** (1911) 1095; MERR. Enum. Philip. Fl. Pl. **3** (1923) 251.

Vaccinium mearnsii ELMER in Leafl. Philip. Bot. **3** (1911) 1098; MERR., in Enum. Philip. Fl. Pl. **3** (1923) 250.

Planta lignosa, terrestris vel epiphytica, 2 ad 10 m alta; foliis oblanceolatis ad oblongis, cuneatis, acuminatis, margine distante glandulosis, 5 ad 10 cm longis, c. 3 cm latis; flores in racemis adscendentibus, rhachidibus puberulentibus 3 ad 8 cm longis; pedicelli c. 5 mm longi, puberulentes; calyx hemisphaericus, c. 3 mm latus, puberulens, lobis 5 acutis, ciliatis, minus quam 1 mm longis; corolla urceolata, c. 8 mm longa, rubra vel apice alba, lobis 5, minutis; stamina 10, 4 mm longa, filamentis sparse pubescentibus, antheribus 1.5 mm longis, oblongis, sine stimulis tubulisque, apice bifidis, poris obliquis hiantibus; ovarium inferius, disco prominente pubescente, stylo glabro 8 mm longo, stigma minuta; fructus ignotus.

Elmer's original description of *Vaccinium sylvaticum* reads as follows:

Epiphytic and shrubby; stems ascending, several, 2 m. long, rebranched from near the base, moderately rigid, covered with smooth grayish mottled bark; twigs ascending, green, glabrous. Leaves also ascending, recurved toward the sharply acuminate apex, base attenuate, deep green and shining on the upper surface, much paler beneath, glabrous, drying brown especially the lower surface, coriaceous, oblong to elliptic with gradually tapering ends, entire and subinvolute in the dry state, less than 1 cm. long, 3 cm. across the middle, the smallest leaves oblanceolate; midrib prominent beneath, usually with 2 pairs of lateral ones arising from near the base, all more or less reticulately anastomosing, the reticulations more evident on the upper side at least in the dry leaves; petiole proper 5 mm. long, glabrous, dark brown. Spicate racemes ascending, terminal or from the uppermost leaf axils, 5 to 8 cm. long, the rachis smooth and green; pedicels recurved, 7.5 mm. long, very finely puberulent, ultimately glabrous; calyx pendulous, cup shaped, 3 mm. high, at least as wide, green, puberulent, the 5 triangularly obtuse teeth purplish white; corolla inflated at the deep red base, 8 mm. long, gradually narrowed toward the small white neck, terminated by 5 ovately triangular 1·mm. long teeth, glabrous; stamens 10, inserted around the base of the corolla; filaments pink at the base, otherwise whitish, filiform, long hairy especially toward the slightly flattened base, 3.5 mm. long; anthers oblong with truncate ends, 1.5 mm. long, dorsally attached toward the base, the upper portion split and with large oblique pores, appendages obsolete; style glabrous, columnar, 8 mm. long, bearing a minutely pulverulent stigma; ovary inferior, with a yellow crown; mature fruit not seen.

Type specimen 11819, *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, September, 1909.

Clumps encircling medium sized tree trunks near the lower limbs of a sharply wooded ridge at 4250 feet along the Mainit creek. "Taupol" is the Bagobo name.

Its affinity lies with *V. malindangensis* Merr., but entirely distinct from that species.

The original description of *Vaccinium mearnsii* reads as follows:

Stunted tree; stem 4.5 cm. thick, 8 to 10 m. high, moss covered; branches rigid, widely spreading toward the top, the ultimate ones rather numerous; wood hard, reddish toward the center, burly, odorless and tasteless, the bark on the branches gray. Leaves rigidly coriaceous, flat or only the abruptly acute apex recurved, base cuneate, glabrous, alternatingly scattered along the smooth and green twigs, deep shining green on the upper side, paler beneath, drying brown but not similarly brown on both sides, quite variable in size, the larger blades 8 cm. long by 3.5 cm. wide across the middle, elliptic or oblongish so, entire and subinvolute in the dry state at least; midrib conspicuous beneath, usually with only 2 pairs of lateral nerves arising from near the base, the upper pair curvingly extending nearly to the apex, reticulations obscure and less evident from the upper

surface; petiole 5 mm. long, glabrous. Inflorescence spicate, chiefly terminal or from the uppermost leaf axils, 3 to 5 cm. long, suberect; rachis green, angular when dry, subtended at the base by short and broad imbricated bracts, in the flowering state finely puberulent; pedicels scattered divaricately all along, strict, also puberulent, 5 mm. long, stout, subtended by vestiges of bracts, articulate or jointed at the base; calyx also articulate, short turbinate, 3 mm. high, finely pubescent, subpendulous, with 5 rather small teeth; corolla crimson red, tapering from the more or less inflated base to the minutely 5-toothed apex, 7 mm. long, 3.5 mm. wide at the base, glabrous; stamens 10, inserted upon the corolla base; filaments sparsely hairy, a trifle wider at the base, nearly 4 mm. long; anther 1.5 mm. long, oblong with truncate ends, attached near the base on the back, the apex with oblique otherwise circular pores, cleft to the middle, without horns; style 5 mm. long, glabrous, terete, bearing a minute stigma; ovary subinferior; young fruit obovoidly globose, 7 mm. long, the small persistent calyx teeth lying flatly over the subtruncate apex; seeds reddish brown, oblong, compressed, smooth, 1.5 mm. in length.

Type specimen 11251, *A. D. E. Elmer*, Todaya (Mt. Apo), District of Davao, Mindanao, August, 1909.

A stocky tree on a moist forested ridge at 3250 feet of mount Burebid. Dedicated to *Maj. E. A. Mearns*, who has burned over the greater portion of the entire chaparral formation of mount Apo, according to the Bagobos, for the purpose of ensnaring mammals. The Bagobo name is "Mangolibas."

Distinct from its nearest Philippine ally, *V. alvarezii Merr.*

MINDANAO, Davao Province, Mount Apo, *Elmer 11819* (W, type), *Elmer 11251* (M, W, type of *V. mearnsii* Elmer).

The differences evident from the descriptions, in habit and in measurements, seem to me not to be significant. The rachises of the racemes are puberulent in all the specimens, and in all of them the pubescence of the filaments is the same.

This species is evidently rare. As its name, I would have preferred to maintain *Vaccinium mearnsii,* since the collection on which this name was based was probably more characteristic of the species; but *Vaccinium sylvaticum* has page priority. *Vaccinium malindangense* Merrill is a herbarium name (see below, among specimens not identified).

24. VACCINIUM BANKSII Merrill.

Vaccinium banksii MERR. in Govt. Lab. Publ. (Philip.) **35** (1906) 54, Philip. Journ. Sci. **3** (1908) Bot. 372, Enum. Philip. Fl. Pl. **3** (1923) 248.

The original description reads:

An undershrub, 1 m. high or less, with lanceolate to elliptical lanceolate, acute or obtuse, short petioled leaves, 4 cm. long or less, and axillary, few flowered racemes about 3 cm. long. Branches striate, glabrous, black and light gray. Leaves coriaceous, 3 to 4 cm. long, 8 to 15 mm. wide, pale beneath, glandular, tapering to the cuneate base, the margins revolute,

slightly undulate; nerves not prominent, ascending, 3 or 4 on each side of the midrib; petioles stout, 2 mm. long or less. Racemes very sparingly pubescent, becoming glabrous or nearly so, the pedicels 3 to 5 mm. long. Calyx sparingly pubescent, 5-toothed, the teeth acute, 1 mm. long. Corolla urceolate, glabrous, 7 mm. long, gradually smaller upwards, shortly 5-lobed, the lobes reflexed, about 1.5 mm. long, obtuse. Stamens 10; filaments about 1.5 mm. long; anthers oblong, 1 mm. long. Ovary glabrous, 5-celled; style stout, nearly 6 mm. long. Fruit unknown.

Type specimen collected by C. S. Banks, Canlaon Volcano, Negros, March, 1902, growing in rather open forests at an approximate altitude [of] 1,300 m. A species related to *Vaccinium cumingianum* Vidal, but quite distinct. Mr. Banks's small collection is to our knowledge the only one ever made on Canlaon Volcano, he having ascended to the summit in March, 1902.

NEGROS, Occidental Negros Province, Canlaon Volcano, *Banks* (M, type), *Merrill* 223 (M, W).

Known only by two collections from the same locality, and these differing in some details. The type is "50–70 cm. high in rather open forests 1300–1350 m." according to a note on the sheet; Merrill's collection is a tree about 7 meters high, from an altitude of about 2,000 meters. The leaves of the type are strictly elliptic, with conspicuous glands at intervals of about 5 mm along the margins; those of the later collection are slightly oblanceolate, and the marginal glands, while definitely present, are obscure. The leaves are glandular-hairy or punctate on the lower surface. Merrill's collection bears a field note that the flowers are red. The rachises, pedicels, ovaries, calyx lobes, disks, and filaments, but not the styles, are pubescent. There are no bracts or bracteoles. The disk is bulkier than the ovary. This character; the character of the leaves; and especially the character of the anthers, which are oblong, without horns, with brief tubes and oblique pores; indicate a close relationship to *Vaccinium jagori.*

25. VACCINIUM WOODIANUM sp. nov.

Vaccinium banksii MERR. in Philip. Journ. Sci. 2 (1907) Bot. 255, 293, not in Govt. Lab. Publ. (Philip.) 35 (1906) 54.

Fruticulus terrestris c. 1 m altus. Folia obovata, 2 ad 3 cm longa, 1 ad 1.5 cm lata, basi cuneata, apice obtusa, margine revoluta, prope apicem glanduloso-crenulato, venis reticulatis obtusis, petiolo 2 ad 3 mm longo. Flores pauci in racemis ebracteatis, rhachide gracile glabro, 1 ad 2 cm longo, pedicellis glabris, c. 7 mm longis. Ovarium hemisphaericum glabrum, calycis lobis 5, ciliolatis, ovatis, obtusis, 1 mm longis. Corolla

urceolata, rubra, 5 mm longa, lobis 5, ovatis, rotundatis. Stamina 10, 4 mm longa; filamentis pubescentibus; antheris lanceolatis 1.5 mm longis, sine stimulis, tubulis brevibus, poris obliquis. Discus puberulens quam ovario latior, stylo glabro 4 mm longo. Fructus ignotus.

MINDORO, Mount Halcon, *Merrill 5506* (M, W), November 20, 1906, altitude 2,700 meters.

This species is known only by a single collection made more than twenty years ago, in the region of heathlike vegetation upon the more extreme heights of Mount Halcon. This collection has been regarded as representing *Vaccinium banksii,* a close relative which differs in having puberulent rachises, pedicels, and ovaries, and shorter stamens. The smaller, proportionally broader, obtuse leaves, and the pubescent disk, distinguish *Vaccinium woodianum* from *Vaccinium jagori,* which is also a close relative.

The species is named for the late Major General Leonard Wood, who organized the expedition on which it was collected, and who, much later, was Governor-General of the Philippine Islands.

26. VACCINIUM JAGORI Warburg.

Vaccinium jagori WARBURG in Perk. Fragm. Fl. Philip. (1905) 174; MERR. in Philip. Journ. Sci. 1 (1906) Suppl. 112, 3 (1908) Bot. 377, Enum. Philip. Fl. Pl. 3 (1923) 250.

Vaccinium angustilimbum MERR. in Philip. Journ. Sci. 12 (1917) Bot. 294, Enum. Philip. Fl. Pl. 3 (1923) 248.

The original description reads:

Frutex glaber, ramis rugulose striatis cinereis, lenticellis vix distinctis, ramulis striatis angulatis in sicco fuscis, petiolis circa 3 mm longis 1½ mm latis, foliis coriaceis obovato-oblongis basi in petiolum angustatis, apice oblique et obtuse apiculatis, 4—5 cm longis 2—2½ cm latis, in sicco fuscescentibus, tri- vel indistincter quinquenerviis, venis utrinque 4—5 quam nervi tertiarii reticulati vix crassioribus. Racemis axillaris et terminalibus quam folia sublongioribus, bracteis nullis (vel deciduis), floribus in pedicellis 4—5 mm longis saepe nutantibus, calyce late infundibuliformi 2 mm lato usque ad medium 5-dentato, dentibus triangulariter rotundatis margine minute ciliolatis; corolla cylindrica 8 mm longa, 2½—3 mm lata, ore valde angustato, lobis 5 fere erectis rotundatis; filamentis longis filiformibus basi lanatis, loculis tubulosis linearibus haud productis poris terminalibus dehiscentibus; ovario glabro, stylo columnari, stigmate haud incrassato.

Philippine Isl., Luzon (JAGOR no. 852) a. 1861.

Ein zweites von JAGOR gesammeltes *Vaccinium*-Exemplar ist steril, es hat breitere und grössere deutlich quintuplinerve Blätter, die aber, was

Form, Textur usw. betrifft, ähnlich sind; es ist vermutlich nur eine Form derselben Art.

That of *Vaccinium angustilimbum*:

Frutex glaber, circiter 3 m altus; foliis coriaceis, lanceolatis ad oblanceolatis, integris, usque ad 6 cm longis et 1 cm latis, nitidis utrinque subaequaliter angustatis, apice obtusis ad leviter acuminatis, basi cuneatis, tenuiter 3-nerviis, nervis lateralibus adscendentibus, margine revolutis; petiolo crasso, brevissimo; racemis terminalibus, solitariis, sub fructu circiter 3 cm longis; fructibus globosis, 5 ad 6 mm diametro, dentibus ovatis, obtusis, 1 mm longis.

A glabrous shrub, about 3 m high, the branches terete, the branchlets brownish, obscurely angled or subterete. Leaves numerous, rather crowded, thickly coriaceous, stiff, lanceolate to oblanceolate, 4 to 6 cm long, 7 to 10 mm wide, subequally narrowed to the cuneate base and to the blunt to obscurely acuminate apex, margins entire, recurved, olivaceous when dry, the lower surface often brownish, glandular, the base slenderly 3-nerved, the lateral basal nerves extending one-half to two-thirds to the apex; lateral nerves, including the basal pair, 3 or 4 on each side of the midrib, slender, sharply ascending, the primary reticulations rather distinct; petioles stout, about 1 mm long. Racemes terminal, solitary, in fruit about 3 cm long, the pedicels up to 5 mm in length. Fruits globose, black when dry, 5 to 6 mm in diameter, the persistent calyx-teeth ovate, blunt, about 1 mm long.

LUZON, Tayabas Province, vicinity of Dingalan, *Bur. Sci. 26603 Ramos and Edaño*, September 10, 1916, in forests, altitude about 300 meters.

A characteristic species distinguishable by its narrow, thickly coriaceous, slenderly nerved leaves. It is perhaps as closely allied to *Vaccinium jagori* Warb. as any other described form, but is very different from Warburg's species.

LUZON, Bataan Province, Mount Mariveles, *Whitford 145* (M, W), *Elmer 7026* (M), *Whitford 1101* (M, W), *For. Bur. 2623 Meyer* (M), *Merrill 3955* (M), *Merrill Decades 282* (M, C, S), *Bur. Sci. 1654 Foxworthy* (M), *Bur. Sci. 1655 Foxworthy* (M): Rizal Province, *Loher 15032, 15097* (M), *Loher 15100* (M, C); Montalban, *Loher 12052, 12303* (M), *Loher 12209* (M, C); Angilog, *Loher s. n.* (M); Mount Irig, *Bur. Sci. 41958 Ramos* (M, W): Tayabas Province, near Infanta, Mount Binuang, *Bur. Sci. 9364 Robinson* (M); Mount Dingalan, *Bur. Sci. 26603 Ramos and Edaño* (M, W, type of *Vaccinium angustilimbum*): Isabela Province, *For. Bur. 18568 Alvarez* (M): Zambales Province, Mount Tapulao, *For. Bur. 9503 Curran and Merritt* (M), *For. Bur. 9512 Curran and Merritt* (M, W), *Bur. Sci. 5024 Ramos* (M): Mountain Province, Benguet Subprovince, Mount Natoo, *Bur. Sci. 40423 Ramos and Edaño* (M): Lepanto Subprovince, Mount Malaya, *For. Bur. 14503 Darling* (M); Bauco, *Vanover-*

bergh 1249 (M): Abra Province, *For. Bur. 14592, 14668-D Darling* (M).

Vaccinium angustilimbum is distinct only in having smaller leaves and in occurring at a lower altitude than is usual in this species. The plant is a shrub or small tree up to 7 meters high, with flowers usually red but varying to white. It is apparently confined to central and northern Luzon, but not common in the Mountain Province. The reported altitudes range from 1,000 to 2,000 meters.

The leaves vary in shape from narrowly elliptic, almost linear, to broadly obovate; and in dimensions from 5 cm by 1 cm (in the Tayabas material) to 8 cm by 3 cm (in specimens from Mount Mariveles). They have always very short petioles; a basal pair of marginal glands, and a few others; conspicuous reticulate venation; a punctate lower surface; and acute apices. Vegetative material cannot with confidence be distinguished from *Vaccinium halconense,* which enters the same range of territory; the reproductive parts, on the other hand, are sharply distinct. There are no bracts; all the parts except the ciliate calyx and pubescent filaments are strictly glabrous; the disk is bulkier than the calyx; the corolla is very narrowly urceolate and reaches a length of 1 cm; the stamens are about 5 mm long, including the anthers, each of which is 1.5 to 2 mm long, oblong, without horns, the tubes short and wide, the pores very oblique. The fruit is glabrous, globular, about 5 mm in diameter, the stumpy calyx lobes erect about the disk, which is about 3 mm in diameter; there are five cells, each divided by a bulky incomplete partition; the numerous seeds are slender, black, about 1.5 mm long.

27. VACCINIUM WHITFORDII Merrill.

Vaccinium whitfordii MERR. in Philip. Journ. Sci. 2 (1907) Bot. 295, 3 (1908) Bot. 372, Enum. Philip. Fl. Pl. 3 (1923) 252.

The original description reads:

Frutex glaber; foliis coriaceis, anguste obovatis vel elliptico-obovatis, basi acutis, apice obtusis, obscure crenatis, usque ad 1 cm. longis; flores axillares, solitarii, rubri, ad 8 mm. longi; filamentis pilosis.

An erect shrub 0.7 to 3 m. high, terrestrial, or sometimes epiphytic, nearly glabrous throughout. Branches slender, gray or brown, angular, the younger ones somewhat puberulent. Leaves 1 cm. long or less, narrowly obovate or elliptical-obovate, coriaceous, glabrous, the apex obtuse, the base acute, the margins somewhat crenate especially above; nerves obsolete or nearly so; petioles about 1 mm. long. Flowers axillary, solitary, the pedicels slightly pubescent, 2 to 3 mm. long. Calyx 3.5 mm. long, the tube ovoid, the lobes spreading, narrowly ovate, glabrous, 1 mm. long. Co-

rolla narrowly urceolate, red, glabrous, 7 to 8 mm. long, 4 mm. wide below, narrowed above and 2 mm. wide below the mouth, the lobes 5, ovate reflexed, acute, 1 mm. long. Stamens 10; filaments 3 to 4 mm. long, thickened below, pilose; anthers oblong, 1.5 mm. long. Style thick, 8 mm. long. Fruit subglobose, or ovoid, glabrous, 5 mm. in diameter.

[Mindoro, Mount Halcon.] On open heaths at 2,400 m. alt. (No. 5798), a shrub about 70 cm. high. Also found in the District of Lepanto, Luzon, at 1,500 m. alt. (No. 5741 *Klemme*) November, 1906, a shrub up to 3 m. in height, and on Mount Silay, Negros (No. 1534 *Withford* [*Whitford*] May, 1906, epiphytic in the latter place.

A species characterized by its small crenate leaves and axillary flowers.

NEGROS, Occidental Negros Province, Mount Silay, *Whitford 1534* (M, W). (This collection bears the type label in the Bureau of Science herbarium, although it is not the first one cited); Canlaon Volcano, *Merrill 6979* (M): Leyte, *For. Bur. 16887 Rosenbluth* (M). MINDORO, Mount Halcon, *Merrill 5798* (M, W). LUZON, "Luzon Central," Bulacloco, *Loher 3768* (W): Rizal Province, *Loher 12599* (M, C): Tayabas Province, Mount Alzapan, *Bur. Sci. 45661 Ramos and Edaño* (C): Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26296 Ramos and Edaño* (M, W): Mountain Province, Ifugao Subprovince, Mount Polis, *Bur. Sci. 19697 McGregor* (M, W), *Bur. Sci. 37611 Ramos and Edaño* (M): Benguet Subprovince, Baguio, *Merrill 712* (M, W); Bucao, *For. Bur. 14428 Darling* (M, W); Pauai, *Clemens 9110* (M), *Bur. Sci. 31971 Santos* (M); Mount Data, *Loher 3769* (W): Lepanto Subprovince, trail to Balbalasan, *For. Bur. 5741 Klemme* (M); Mount Malaya, *For. Bur. 16581 Darling* (M): Bontoc Subprovince, *For. Bur. 13405 Klemme* (M), *For. Bur. 10976 Curran* (M, W): Abra Province, Mount Paraga, *Bur. Sci. 7108 Ramos* (M): Ilocos Norte Province, Mount Nagapatan, *Bur. Sci. 33210 Ramos* (M).

All these collections represent a very uniform race of plants, shrubs, terrestrial in all collections except the type, occurring at altitudes from about 1,000 to about 2,500 meters.

The flowers are not, strictly speaking, axillary; a definite articulation at the base of the short pedicel shows that it is terminal upon an axillary branch a fraction of a millimeter long. This prefix to the pedicel, but not the pedicel itself, is clothed by several minute bracteoles. The petioles and bracteoles are sparsely puberulent, and occasionally the calyx lobes are shortly ciliate, and sometimes the base of the ovary bears a few trichomes. The disk is moderately prominent, glabrous; the style is glabrous. The anthers, which I would describe as obovoid, are very characteristic; they lack horns or tubes, and the pores

flare widely open. The fruits, about 5 mm in diameter, are purple or black at maturity. Internally the fruit shows five cells, each divided into two by a partition which extends from the periphery nearly to the middle; only a few of the ovules develop into seeds. The seeds are red-brown, fusiform, about 1 mm long.

SUBSECTION 8. ALLIES OF VACCINIUM MYRTOIDES

Mostly terrestrial plants of high altitudes. Leaves tough, less than 3 cm long, ovate or elliptic, with basal marginal glands. Racemes usually bracteate. Anthers without horns.

The well-known Javan species, *V. varingiaefolium* and *V. lucidum,* which fall within the above definition, have conspicuously bracteated racemes, considerable pubescence on the flower parts, and disks more bulky than the ovaries. *Vaccinium myrtoides* is definitely a close relative of these species, although notably differing from them in having the disk smaller than the ovary; it is not apparently equally close to *V. jagori* and *V. cumingianum,* although resembling these species in various respects. I regard *V. myrtoides* as the only Philippine species of its subsection. With this species and with *V. varingiaefolium* and *V. lucidum* can probably be included the Sumatran *V. dempoense* Fawcett and the Bornean *V. buxifolium* Hooker f.

28. VACCINIUM MYRTOIDES (Blume) Miquel.

Vaccinium myrtoides (Blume) MIQ., Fl. Ind. Bat. 2 (1859) 1062, Ann. Mus. Bot. Lugd. Bat. 1 (1863) 38; MERR. in Philip. Journ. Sci. 12 (1917) Bot. 293, Enum. Philip. Fl. Pl. 3 (1923) 250; J. J. SM. in Meded. Rijks. Herb. Leiden No. 30 (1916) 7.

Thibaudia myrtoides BLUME, Bijdr. (1826) 861.

Agapetes myrtoidea G. DON, Gen. Syst. 3 (1834) 863; DUNAL in DC. Prodr. 7 (1839) 555.

Vaccinium microphyllum F.-VILL., Noviss. App. (1880) 121 in part; KOORDERS in Meded 's Lands Plant. 19 (1898) 514; non Reinw.

Vaccinium varingiaefolium ? VIDAL, Sinopsis Atlas (1883) t. 60, f. D., non Miq.

Vaccinium villarii VIDAL, Rev. Pl. Vasc. Filip. (1886) 166; ROLFE in Journ. Bot. 24 (1886) 348; MERR. in Philip. Journ. Sci. 2 (1907) Bot. 294, 3 (1908) Bot. 374, 5 (1910) Bot. 372; ELMER in Leafl. Philip. Bot. 3 (1911) 1092.

Vaccinium sp. VIDAL in Phan. Cum. Philip. (1885) 27, 123.

Blume's original description, under *Thibaudia,* reads as follows:

T: ramulis pubescentibus, foliis ex ovato-ellipticis obtusiusculis margine recurvis coriaceis subvenosis ad costam utrinque puberulis, racemis glabris.

Crescit: in cacumine montium ignivomorum insularum Moluccarum.

Floret: omni tempore.

The original description of *Vaccinium villarii* reads:

Frutex vel fruticulus; ramis ramulisque griseo pubescentibus. Folia brevissime petiolata, ovalia, utrinque sub-acuta vel apice, interdum calloso. sub-rotundata, longa 10-25 cm. [sic! should be mm] lata 5-12 mm., margine integerrima revoluta, coriacea, supra nitida, in sicco sæpissime brunnea, subtus ferruginea vel ferrugineo-maculata, basi sub-trinervia; nervis lateralibus ad 6, basilaribus adscendentibus, reticulatis, prominulis vel rarius obsoletis. Racemi axillares aut pseudo-terminales, pauciflori. Calycis tubus sub-globosus, ore angustatus; lobis triangularibus tubo brevioribus; circ. 3 cm. [sic! should be mm]. longus. Corolla urceolata; ore leviter contracta, lobis brevibus, sub-acutis; calyce duplo longior, rubella. Antherarum loculi vix producti, poris dehiscentes (Sect. *Epigynum. a.* Hook. f.). Bacca globosa, sæpissime calyce coronata vel areolata, ad 5 mm. diam., cæruleo-nigrescens.

Synom.—*V. varingiæfolium,* Miq.?, Vid. Sinops. t. 60 f. D. (foliarum nervatura mala); *V. microphyllum,* F. Vill. Noviss. Append. 121 in parte, non Reinw.

414 Monte Banahao, 2.000 m. alt., Pr. Tayabas; 817 Volcan Mayon, Pr. Albay; 1533 Distr. Lepanto.—Cum. 935 Pr. Albay.

El P. Fernandez-Villar incluye esta especie y la siguiente en *V. microphyllum,* Reinw; pero me parecen distintas de ella (inflorescencia &), de ambas esta es la que parece más afine.

Miquel had not seen material of this species when he changed the name, in 1859; in 1863 he redescribed it on the basis of typical and other material, part of which J. J. Smith has since separated as a variety *celebicum.* Miquel included also, doubtfully, a β var., based on an imperfect specimen, which, according to Smith, probably represents *Vaccinium dempoense* Fawc.

I quote in full Smith's description, based on the type specimen in the Rijks Herbarium at Leiden:

Frutex ramulis puberulis. Folia alterna, parva, brevissime petiolata, ovata ad oblongo-ovata, apice angustata, obtusa, basi obtusa, margine in sicco recurva, integerrima, glandulis marginalibus 1–2 parvis impressis utrinque supra basin, adulta glabra, basi tantum puberula et ciliata, novella apice ciliata, in utraque parte costae mediae nervis lateralibus ca. 4—5 patentibus intre marginem anastomosantibus tenuibus, reticulato-venosa, nervis venisque sicco subtus plus minusve prominulis, coriacea, ca. 1, 3—2 cm longa, 0,6—0,75 cm lata, vel etiam 1,5 cm longa, 0,825 cm lata; petiolus puberulus, ca. 0,075—0,1 cm longus. Inflorescentiae axillares, racemosae, breves, ca. 6-florae, ca. 1,1—1,6 cm longae, rachide puberula. Flores parvi, nutantes, pedicellati, pedicello tenui, tereti, apice leviter incrassato et cum ovario articulato, glabro, ca. 0.47 cm longo. Calyx 5-partitus, laciniis corollae adpressis, triangulis, acutis vel subacutis, partim (ca. 2) minute glanduloso-apiculatis, glabris, ca. 0,075 cm longis, 0,1 cm latis. Corolla urceolata, 5-loba, utrinque glabra, explanata ca. 0,45 cm longa, 0,65 cm lata, lobis triangulis, obtusis, ca. 0,075 cm longis, 0,1—0,125 cm latis. Stamina 10, ca. 0,2 cm longa vel paulo longiora; filamentum latius lineare, inferne leviter dilatatum, curvum, antice convexum, villosum,

superne parce pilosum; anthera dorsifixa, oblonga, usque ad medium bifida, basi obtusissima retusaque dorso mutica, magnam partem echinulato-papillosa, 0,1 cm interdum paululum superantes, thesis antice sulco separatis, sulco oblique laterali conspicuo instructis, tubulis erectis, contiguis, apice oblique, introrsum truncatis, poro obliquo introrso hiantibus. Ovarium globosum, glabrum, ca. 0.22 cm diam.; stylus crassiusculus, teres, truncatus, glaber, bene ca. 3 cm [sic! should be 0,3 cm] longus. Discus annulari-pulviniformis, medio excavatus, dense subadpresse hirsutulus ca. 0,15 cm diam.

Patria ? (Herb. Lugd. Bat. no. 899, 145—76 —77; das linke, bei no. 76 aufgeklebte Exemplar ist *Vaccinium varingifolium* MIQ.; die Blüten in der Schachtel bei no. 77 gehören zu *Vaccinium dempoense* FAWC.).

Tidore: Auf dem Gipfel. (Reinwardt, Aug. 1821); Herb. Lugd. Bat. no. 899, 145—74, das rechte Exemplar; no. 908, 265—1357; no. 899, 145—75, —78, —79).

Merrill (1917) writes in part as follows:

> *Koorders 19438, 19429* from Klabat and Sepoetan, Celebes, exactly match our very full series of Philippine *Vaccinium villarii* Vid., and as the specimens conform with Blume's diagnosis, I have no hesitation in reducing Vidal's species to the very much older *Vaccinium myrtoides* Miq. This adds another characteristic species to the already long list of those that are known only from the Philippines and Celebes, or from the Philippines and the Moluccas.

It has been shown above that the type locality is Tidore.

J. J. Smith (op. cit. 8) has described a variety *celebicum*, based on the Celebes collections of Reinwardt and Forsten. He remarks in a letter to Merrill (filed in the herbarium of the Bureau of Science at Manila) that the Celebes collections of Koorders are almost certainly identical with this, and that the Philippine material is also probably representative of the same variety. I have not seen any of the Celebes and Molucca material; I find in the description quoted above no basis for distinguishing the Philippine material as a variety.

MINDANAO, Davao Province, Mount Apo, *Copeland s. n., 1052, 1418,* (M, W), *Mearns s. n.* (W, 4 sheets), *Williams 2576* (M), *Elmer 11392* (M), *Elmer 11767* (M, W), *Clemens 15682* (C). MINDORO, Mount Halcon, *Merrill 5502* (M, W). LUZON, Albay Province, Mount Mayon, *Bur. Sci. 2949 Mearns* (M), *Bur. Sci. 6493 Robinson* (M), *Bur. Sci. 19027 Rosenbluth* (M): Laguna Province, Mount Banahao, *Loher 6204* (M, W), *Bur. Sci. 2390 Foxworthy* (M, W), *For. Bur. 7891 Curran and Merritt* (M), *Bur. Sci. 6063 Robinson* (M, W), *Bur. Sci. 6561 Robinson* (M), *Bur. Sci. 30077 Sulit* (C); Mount San Cristobal, *Gates 6372* (M): Mountain Province, Benguet Subprovince, *Merrill 1166* (M, W), *Bur. Sci. 2830 Mearns* (M), *Bur. Sci. 5376 Ramos* (M);

Baguio, *Topping 56* (M, W), *Elmer 5955* (M, W), *For. Bur. 951 Barnes* (M, W), *Williams 1156, 1458* (M, W), *Santos 35* (M), *McClure 15900* (C), *For. Bur. 30191 Lagasca* (M, C), *For. Bur. 30492 Lagasca* (C); Cervantes trail, *For. Bur. 25158 Garcia* (M); Loö, *For. Bur. 10937 Curran* (M), *Bur. Sci. 5934 Ramos* (M); Pauai, *Bur. Sci. 4274 Mearns* (M), *Bur. Sci. 8419 McGregor* (M), *Bur. Sci. 31841 Santos* (M); Mount Pulog, *For. Bur. 16177 Curran, Merritt, and Zschokke* (M), *Bur. Sci. 44881 Ramos and Edaño* (M, C); Mount Data, *Loher 3774* (M): Lepanto Subprovince, Bauco, *Vanoverbergh 287, 3869* (M): Ifugao Subprovince, Mount Polis, *Bur. Sci. 37634 Ramos and Edaño* (M, W).

A shrub, from about 0.3 to 2 meters high; flowers white or pink; young fruits red, ripe ones blue-black with a bloom, edible; altitude from about 1,000 meters on Mount Mayon to about 3,200 meters on the summit of Mount Apo. There are usually two glands on each edge of the leaf blade near the base; the specimens from Mount Apo are distinct in having only one on each side. The young stems are pubescent. Bracts, 3 to 12 mm long, of exactly the appearance of leaves but smaller and narrower in proportion to their length, are produced at the lowest or at all the nodes of the raceme; they may be quickly deciduous, or persistent until after the fruit is shed. The rachises, about 2 cm long, are usually but not always glabrous; the pedicels, 3 to 10 mm long, are glabrous; the ovary is subglobular, about 2 mm long, glabrous; the triangular calyx lobes may be glabrous or slightly ciliate at the tips; the disk, convex and prominent, but less bulky than the ovary, is pubescent, sometimes only sparsely so; the style is glabrous. The fruit is about 5 mm in diameter; the calyx lobes are folded over the disk, and form a conical crown about 1.5 mm in diameter. Internally, the fruit is 5-celled, with each cell divided by an incomplete false partition; each half-cell contains many brown fusiform seeds, each about 1 mm long, arranged in a single column.

Section OARIANTHE Schlechter

Vaccinium sectio *Oarianthe* SCHLECHTER in Englers Bot. Jahrb. 55 (1918) 169.

Suffrutices humili, terrestres vel epiphytici, foliis parvis; flores parvi, solitarii, axillares, in pedunculis bracteolatis; ovarium 5-loculatum, loculis pluriovulatis; limbus calycis, super in ovario insertionem, breviter synsepalus; antherae saepius dorso muticae, tubulis brevissimis per rimis ventralibus dehiscentibus.

Incolant Novam Guineam, specie unico in Celebes insulisque Philippinis.

As type of the group I believe that one should select *V. finisterrae,* the first, not of the species of British and Dutch New Guinea cited by Schlechter, but of the species described by him from German New Guinea (northeast New Guinea, now a British mandate).

Our single species is distinguished from most of its relatives by elongated pedicels, a broad but not prominent disk, and glabrous filaments.

29. VACCINIUM MICROPHYLLUM Reinwardt.

Vaccinium microphyllum[10] REINW. ex Blume Bijdr. (1826) 851; G. DON, Gen. Syst. 3 (1834) 857; DUNAL in DC. Prodr. 7 (1839) 576; MIQ., Fl. Ind. Bat. 2 (1858–9) 1063, Ann. Mus. Bot. Lugd. Bat. 1 (1863) 38; MERR. in Philip. Journ. Sci. 1 (1906) Suppl. 221, 3 (1908) Bot. 371, Enum. Bornean Pl. (1921) 464, Enum. Philip. Fl. Pl. 3 (1923) 250; ELMER in Leafl. Philip. Bot. 3 (1911) 1092.

Vaccinium mindorense RENDLE in Journ. Bot. 34 (1896) 355; MERR. in Philip. Journ. Sci. 2 (1907) Bot. 293.

Diplycosia microphylla CLARKE in Hook. f. Fl. Brit. Ind. 3 (1882) 458, non Becc., in part.

The original description in Blume's Bijdragen falls under the subgeneric heading "*Antheris dorso muticis, calicibus ebracteatis,*" and reads as follows:

VACCINIUM MICROPHYLLUM, Herb. Rwdt.

V: caule fruticuloso, ramulis puberulis, foliis ovalibus obtusis integerrimis margine recurvis venosis coriaceis glabris, pedunculis subsolitariis axillaribus unifloris, corollis urceolatis.

Crescit: in montosis insulae Celebes.

Floret: forte omni tempore.

Rendle's original description of *Vaccinium mindorense* reads as follows:

Fruticosus, ramis ramulisque tenuibus rigidis ascendentibus bene foliatis, junioribus puberulis; foliis glabris coriaceis parvis ovalibus integris uninerviis; floribus solitariis pedicellatis; calycis lobis late triangularibus; corolla urceolata laete purpurea, lobis brevibus recurvatis; staminibus 10, in corolla inclusis, filamentis planis glabris, antheris muticis, minute pu-

[10] *Vaccinium microphyllum* F.-Vill., Noviss. App. (1880) 121 = *Vaccinium myrtoides* Miq. and *V. cumingianum* Vid. *V. microphyllum* Rydberg in Bull. Torr. Bot. Club 24 (1897) 251, Ind. Kew Suppl. 2 (1904) 190 = *Vaccinium scoparium* Leiberg; *V. microphyllum* Koorders in Meded. Lands Plant. (1898) 514 = *Vaccinium myrtoides* Miq. probably var. *celebicum* J. J. Sm.; *V. microphyllum* King and Gamble, Mat. Fl. Mal. Pen. 4 (1905) 272 = *Diplycosia sp., Diplycosia microphylla* Clarke non Becc.

berulis, poris apicalibus dehiscentibus; ovario infero cum pedicello articulato, loculis pluriovulatis; stylo super basin tenuem inflato lineari-oblongo sub stigmate capitato angustato.

Hab. Mindoro Is., Mt. Dulangau.

Apparently a small herb with straggling growth; the stiff branchlets reaching 23 cm. in length. The small spreading leaves have a short stalk 2 mm. or less in length, and a blade of very uniform shape, 10—12 mm. long by 3.5—5 broad. The pedicel is 6 mm. long, and articulated with the ovary. The broad spreading calyx lobes bear at their tips a tuft of short hairs. The bright crimson corolla is 6 mm. long, 3 mm. across the mouth, and 5 across the inflated lower portion; the blunt lobes are 1.5 mm. long. The stamens, including the anther (1.5 mm.) are 4 mm. long; the style and stigma are also 4 mm. The style becomes suddenly inflated above the base, assuming a linear-oblong shape.

Has the habit of *Diplycosia microphylla* Becc.

Merrill (1908) remarks in part as follows:

This is a critical species, the exact range of which outside of Celebes and the Philippines is somewhat doubtful, but extending to Borneo, Malacca and Perak according to King and Gamble. I had previously identified the small congested form from the summit of Mount Apo with Blume's species, but an examination of the type in Herb. Leiden shows that the lax form, typified by *Vaccinium mindorense* Rendle, is closer to it. From the notes I made on the types of *V. mindorense* and *V. microphyllum*, and from a reëxamination of the Philippine material I can not find any distinguishing characters, and accordingly have here reduced Rendle's species. On Mount Halcon, according to my own observations, and on the Cuernos Mountains in Negros, according to Elmer, the species occurs both as an epiphyte and terrestrial, and I have both terrestrial and epiphytic forms from Mount Apo. At first sight the Apo epiphytic form appears to be very different from the terrestrial one, but careful examination shows no distinguishing characters except vegetative ones, the terrestrial form occurring at higher altitudes in exposed situations and naturally having smaller and more densely crowded leaves than has the epiphytic form, while the whole plant is much congested.

Elmer remarks:

A creeping, dwarfed and rigid shrub, mostly in rock crevices all over the rocky summit of Mount Apo above the timber line and in the chaparral; leaves rigid, shining green, much paler green beneath, densely clothing the ultimate branches; flowers subpendulous as are also the fruits; berries steel blue when ripe, ovoidly globose, covered with a thin skin, very juicy and possess a fine sweet flavor. The Bagobos call it "Manalali."

Represented by species [specimen] 11394, *Elmer*, Todaya (Mt. Apo), Mindanao, August, 1909.

The flowers of the above species are rather inconspicuous, greenish yellow or yellowish white, the fruits bluish. Those of my number 9540 from the summit of the Cuernos mountains of southern Negros are showy, shining vermillion red and its berries somewhat the same color. The latter number was distributed under *V. mindorense Hemsl.*, [sic!] because

of *Merrill's* specimen from the topotype [i. e., from the type locality of *V. mindorense*] are noted as having red flowers. My specimen from mount Apo is a true Vaccinium, but not at all *V. microphyllum Blm.* in *King* et *Gamble's* Mat. Fl. Mal. Pen. n. XVI, p. 62 which description is that of a *Diplycosia.*

Merrill (1921) remarks as follows, speaking of *Diplycosia microphylla* Becc.:

Sarawak, *Beccari 2031*! This is not *Vaccinium microphyllum* Blume, which is a true *Vaccinium*, and which was erroneously reduced by Hooker f. to Beccari's species. King & Gamble consider it as *Vaccinium microphyllum* Blume, but I consider the Malay Peninsula form (*Wray 1105*! *Scortechini 1171*!) to be distinct not only from Blume's species, but also from *Diplycosia microphylla* Becc.

I have seen a specimen of this plant of the Malay Peninsula, from the state of Pahang. The collector's name is illegible. The plant is a *Diplycosia*, and is only superficially similar to *Vaccinium microphyllum* Reinw.; its leaves have plane margins with glands at intervals throughout their length.

Vaccinium microphyllum appears not to have been recollected in Celebes. A letter from the late Dr. M. Treub to Merrill mentions a sterile specimen collected by Teysmann in Ternate. This letter and one from Dr. J. J. Smith state that the specimens on which Koorders's reference was based are certainly not representative of the species in question, as they have the flowers in racemes, but belong "almost certainly" to *Vaccinium myrtoides* var. *celebicum* J. J. Sm. The letters are filed in the herbarium of the Bureau of Science, Manila.

The synonymy of the North American *Vaccinium scoparium* Leiberg (including *Vaccinium myrtillus* var. *microphyllum* Hooker, which became for a time *Vaccinium microphyllum* Rydberg) illustrates the danger of applying to a variety a name belonging to any species in the same genus, and of applying a particular specific name to a species when there is in existence "an earlier homonym" which somebody or other regards as "non-valid."

MINDANAO, Davao Province, Mount Apo, *Copeland s. n.* (M), *Copeland 1037, 1417* (M, W), *Mearns s. n.* (W, 3 sheets), *Elmer 11394* (W), *Clemens s. n.* (C). NEGROS, Occidental Negros Province, Canlaon Volcano, *Merrill 234* (M, W) : Panay, Antique Province, Mount Madiaas, *Yoder* (M). MINDORO, Mount Dulangan, *Whitehead* (M, fragm. ex Herb. Kew, type of *V. mindorense*) ; Mount Halcon, *For. Bur. 4414 Merritt* (M), *Merrill 5676* (M, W). LUZON, Laguna Province, Mount Banahao, *Merrill 7519* (M).

Altitude from 1,400 meters, on Mount Halcon, to about 3,200 meters, on the summit of Mount Apo, the highest point in the Philippine Islands.

The variation in vegetative characters, mentioned by Merrill in the quotation above, is obvious from the specimens; the range of variation is from usually epiphytic plants with distant leaves whose dimensions are about 18 by 8 mm, to depressed terrestrial plants with crowded leaves whose dimensions are about 7 by 3 mm. The stems and the petioles, 1 to 2 mm long, are puberulent. Obscure veins other than the midrib may be detected. The recurved leaf-margins bear, on each side near the base, a single gland; others can sometimes be detected on the lower surface.

The variability in color of flowers and fruits, mentioned by Elmer, is evident from the field notes attached to the various collections. The flowers are not, strictly speaking, axillary; they are terminal on axillary branches, often less than 1 mm long, which bear minute bracteoles. The pedicel is swollen at the summit; upon it and upon the ovary one can sometimes detect a few capitate trichomes. I have been able to detect, on the calyx lobes of one specimen from Mount Halcon, the hairs which Rendle mentions; they seem usually to be absent. Below the lobes, and above the ovary, the calyx forms a short subrotate tube. The summit of the ovary does not project above the insertion of the calyx tube, but is flat; it is glabrous. The fruit, less than 1 cm in diameter, is obconical, the summit broad, surrounded by the calyx lobes. There are five cells; these contain no false partitions. The seeds, in several rows in each cell, are laterally flattened, oval, yellow, less than 1 mm long.

The glabrous filaments, the flat top of the ovary, the synsepalous calyx, and the undivided cells of the ovary, distinguish this species sharply from all other species of *Vacciniums* occurring in the Philippines.

SPECIMENS NOT IDENTIFIED

MINDANAO, Misamis Province, Mount Malindang, *For. Bur. 4579 Mearns and Hutchinson* (M, W), May 20, 1906. Altitude 1,000 meters; habit ?; in young fruit. The elliptic-acuminate, very veiny, leaves are about 7 cm long; they have glands on the lower surface and one or two on each margin near the base. Rachises, pedicels, ovaries, and disks glabrous. Acicular bracts a few millimeters long are present. Disk not bulky. The undescribed species seems to belong near *V. halconense*. The

Manila specimen is marked "*Vaccinium malindangense* Merr." When other specimens representing this form are known, it may be well to describe them under this name.

LUZON, Province of Nueva Vizcaya, Carballo Mountains, *Loher s. n.* (C, sheet number 22418), March 1915. Slightly past flowering. No field data. Leaves elliptic, 6.5 cm long, resembling those of *V. jagori,* but obtuse and petioled. Rachises, pedicels, ovary, and disk much as in *V. jagori.*

LUZON, Laguna Province, Luisiana, *For. Bur. 24660 Alvarez* (M), November 6, 1915. Altitude 500 meters; a tree, said to be 25 meters high; fruits (unripe) red. Resembles *V. benguetense;* leaves larger, with much more prominent midrib, and margins strongly recurved.

ILLUSTRATIONS

Plate 1

Fig. 1. *Vaccinium philippinense* Warburg. *Elmer 17938*, stamen, × 10.
2. *Vaccinium philippinense* Warburg. *Elmer 17938*, flower and bract, × 5.
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4. *Vaccinium agusanense* Elmer. *For. Bur. 25223 Alvarez*, flower and bract, × 5.
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Plate 2

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3. *Vaccinium indutum* Vidal. *Bur. Sci. 38918 Ramos and Edaño*, fruit, × 2.5.
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5. *Vaccinium barandanum* Vidal. *Vanoverbergh 1053*, stamen, × 10.
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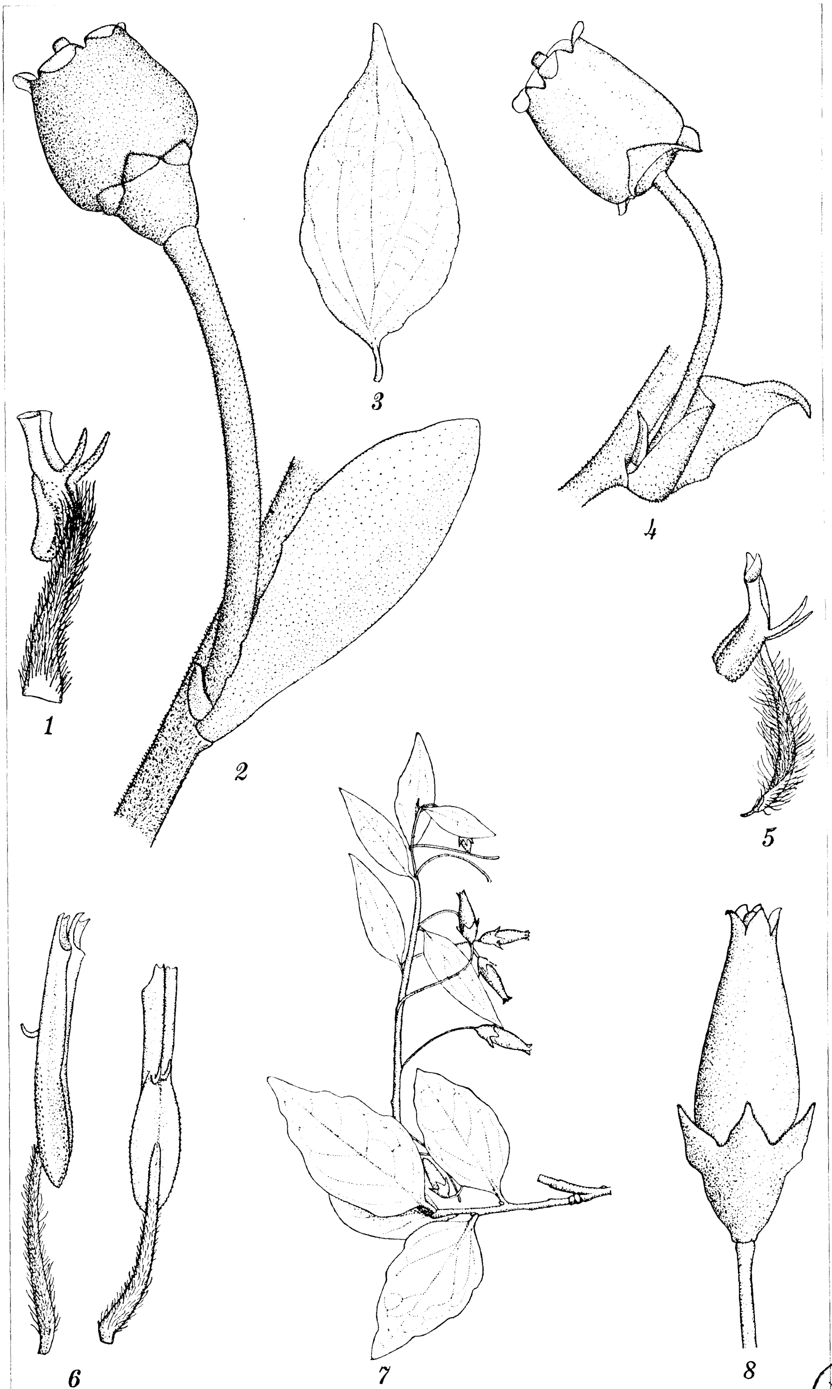

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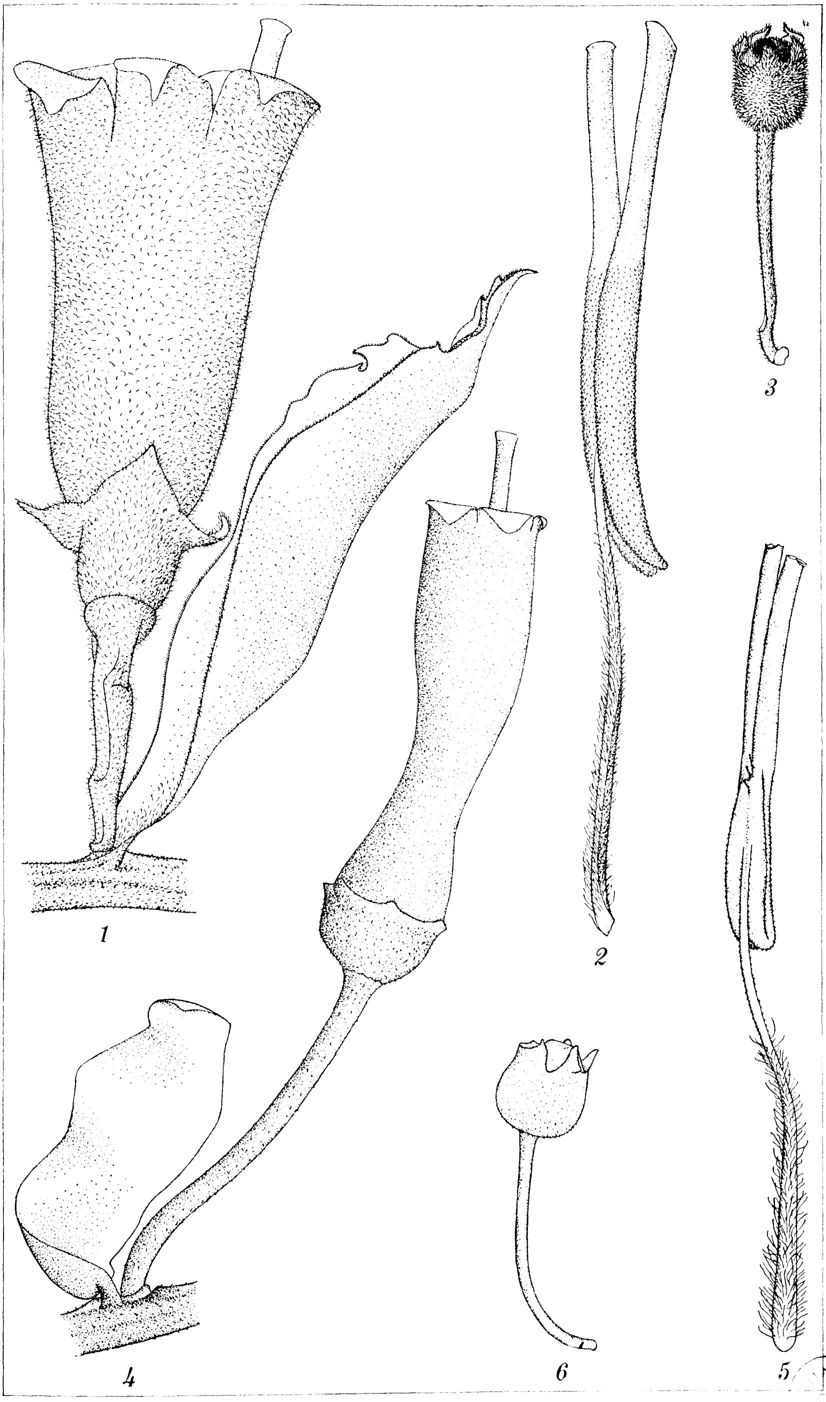

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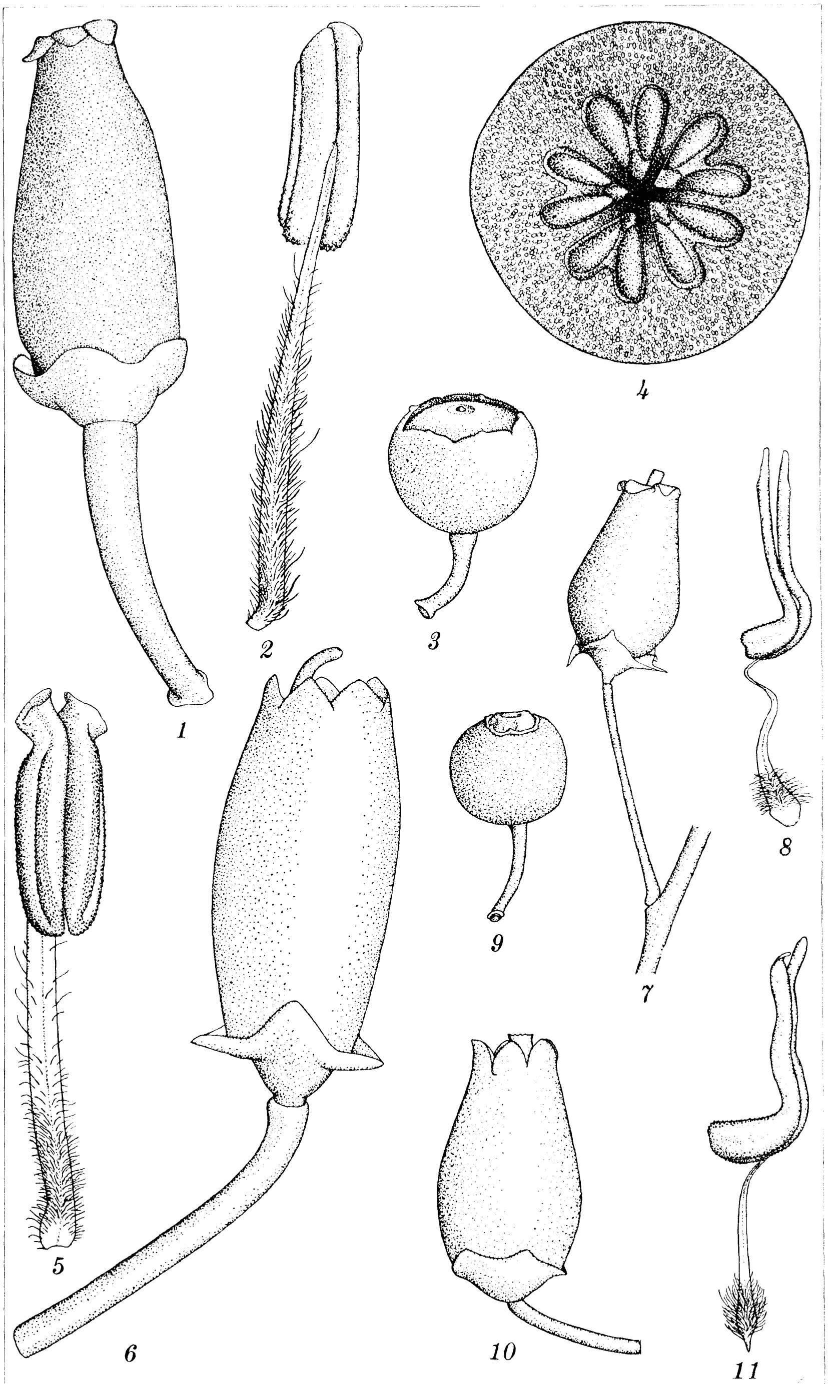

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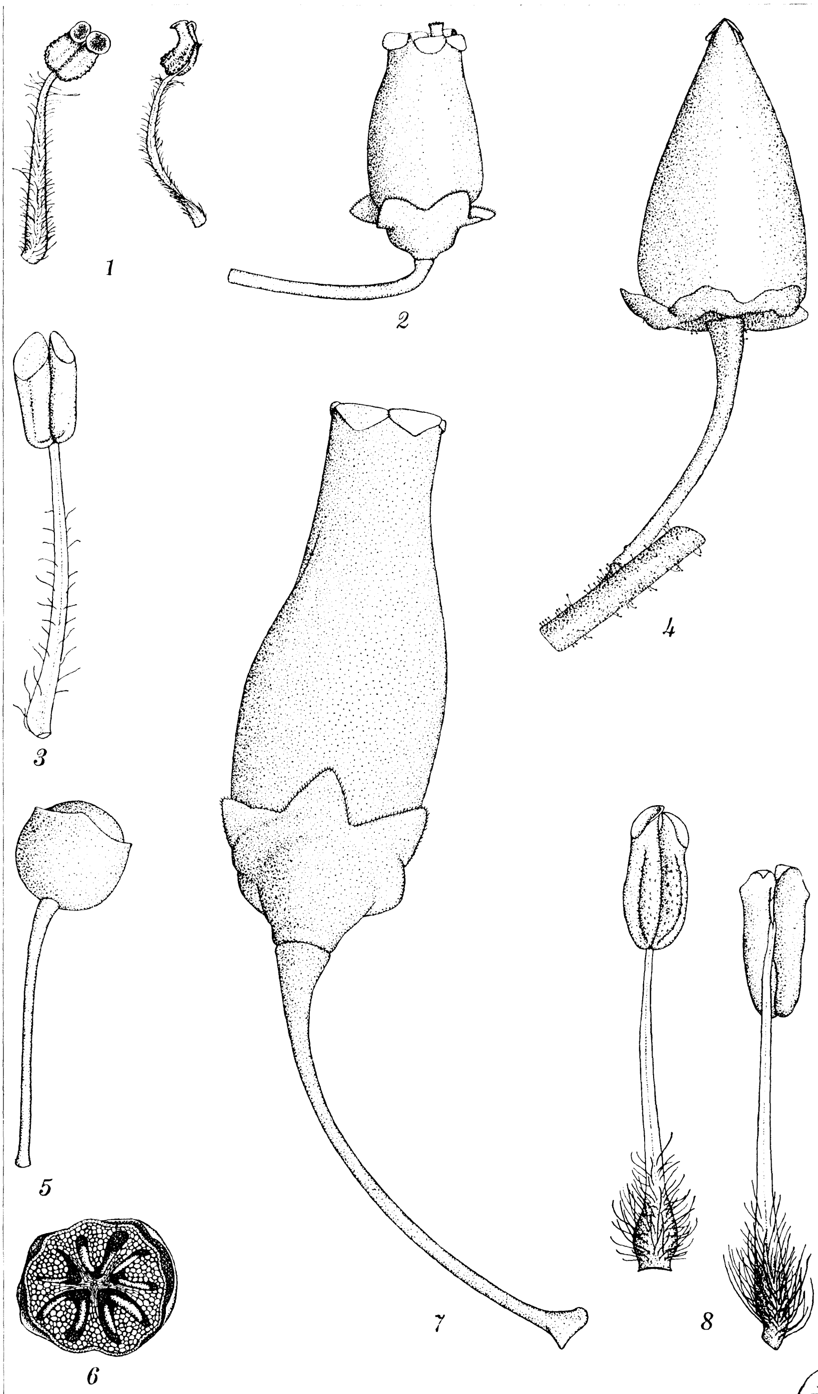

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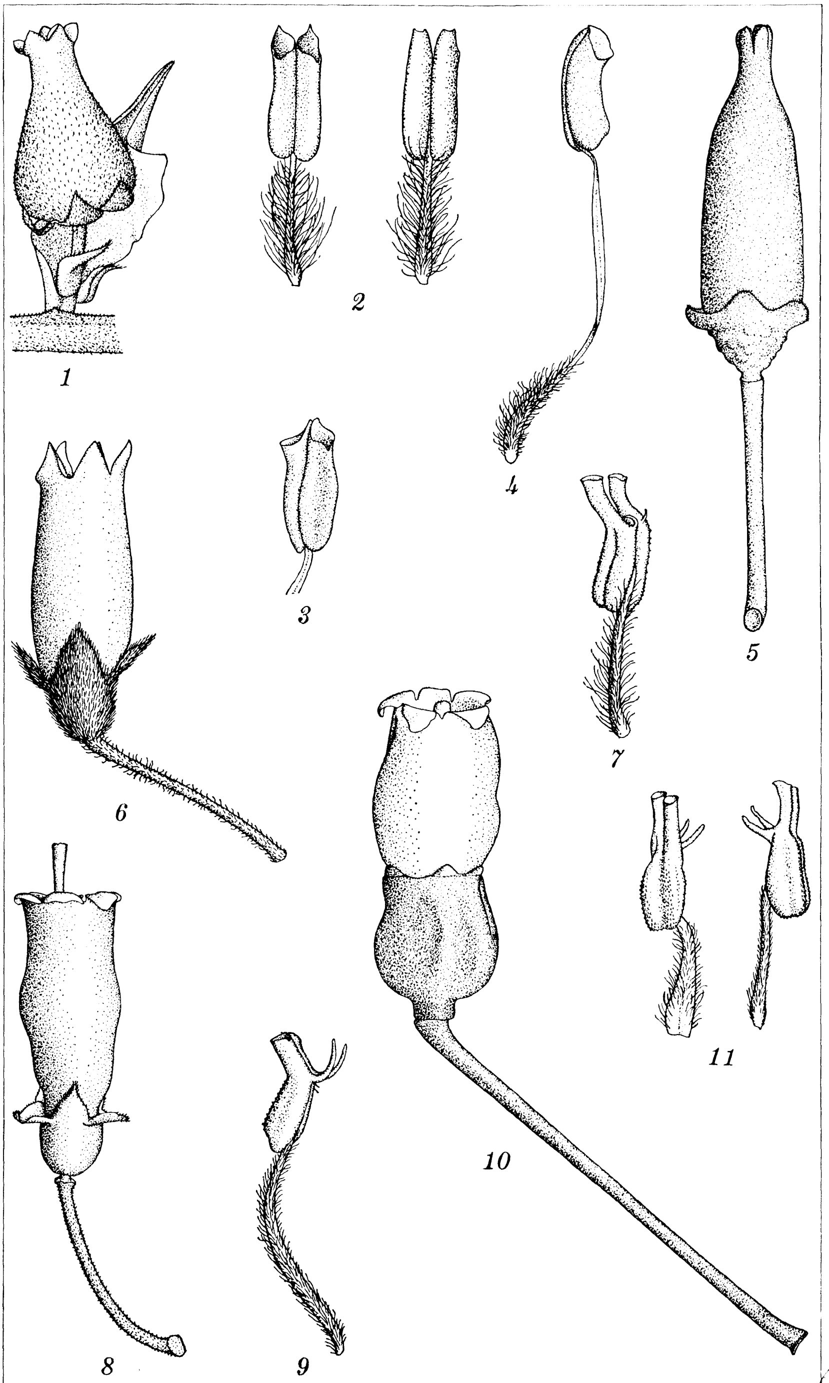

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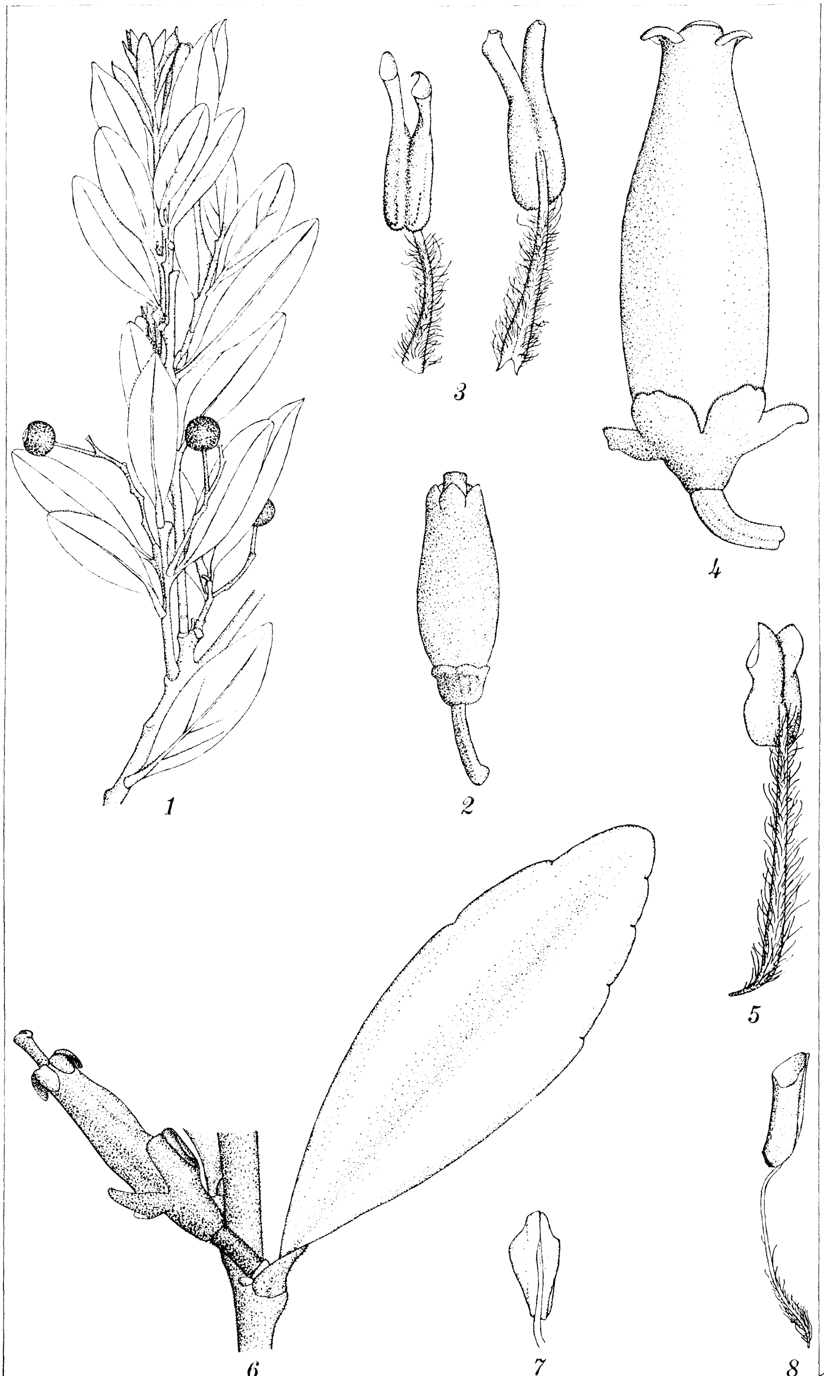

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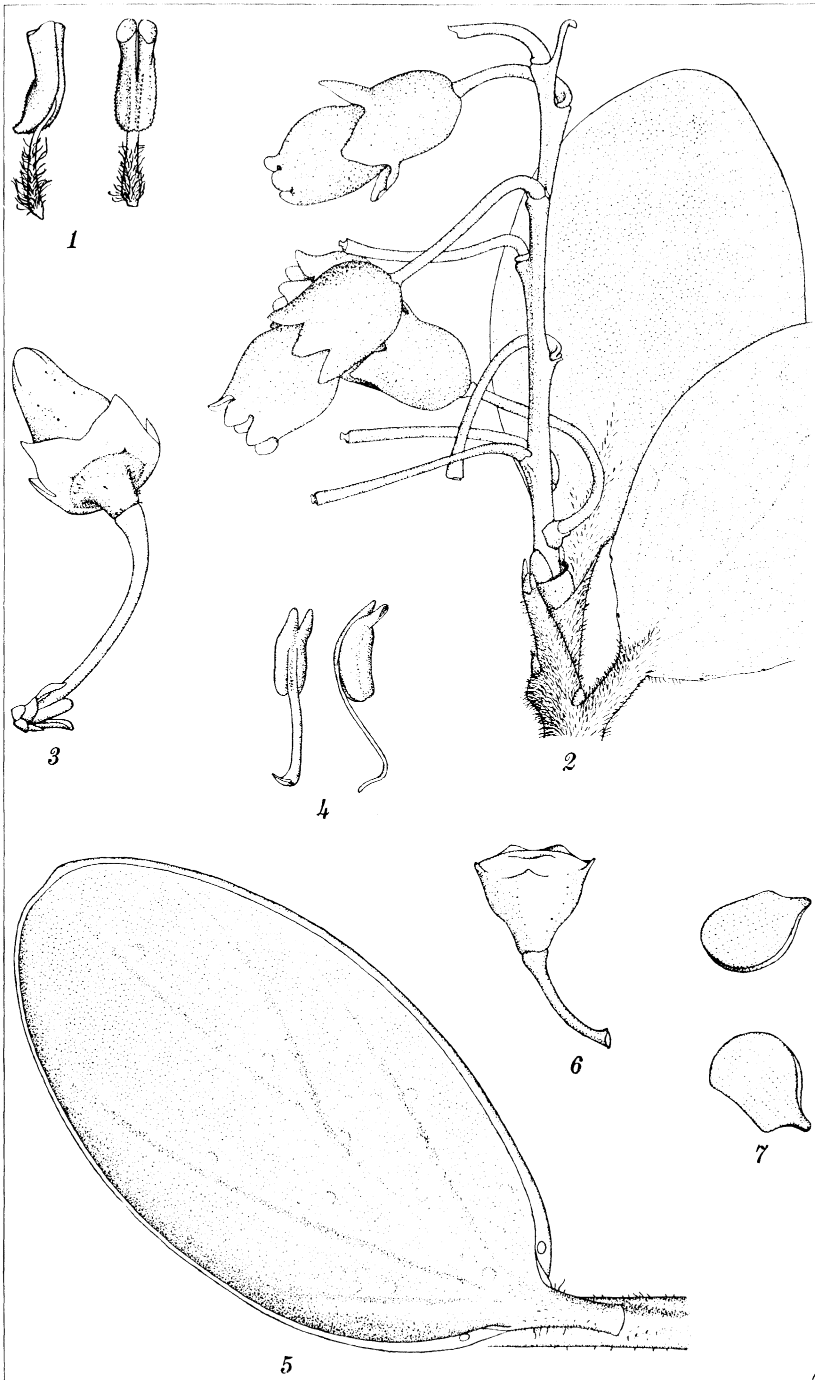

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